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Mineral Resources of Kansas.

1902.

Gold and Silver.
Lead and Zinc.
Coal.
Oil and Gas.
Clay Products.
Gypsum
and Gypsum Cement Plasters.
Hydraulic and Portland Cements.
Building and Other Stone.
Salt.
Kansas River Flood of 1903.

THE

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CONDUCTED UNDER AUTHORITY OF THE BOARD OF REGENTS OF THE UNIVERSITY OF KANSAS, AS AUTHORIZED BY SPECIAL LEGISLATION.

ANNUAL BULLETIN

ON THE

MINERAL RESOURCES OF KANSAS, 1902,

INCLUDING A REPORT UPON GOLD AND SILVER, LEAD AND ZINC, COAL, OIL, GAS, CLAY PRODUCTS, GYPSUM, HYDRAULIC AND PORTLAND CEMENTS, BUILDING STONE, AND SALT.

By ERASMUS HAWORTH,
State Geologist.

LAWRENCE, KANSAS:
JULY, 1903.

The Geological Survey publications are distributed from the University, at Lawrence.

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LETTER OF TRANSMITTAL.

Dr. Frank Strong, Chancellor of the University of Kansas:

DEAR SIR—I have the honor to submit herewith my annual report on the mineral resources of Kansas for the year 1902, which will constitute the fifth annual bulletin of this series. It affords me pleasure to state that the mining and metallurgical interests of Kansas during the year were in a prosperous condition, and constitute an important factor in the production of the state's wealth. Many of the industries increased their yield, making the value of the total output of mining and metallurgical products the greatest yet recorded in the state's history.

Yours most respectfully,

ERASMUS HAWORTH,
State Geologist.

DEPARTMENT OF GEOLOGY AND MINERALOGY,
UNIVERSITY OF KANSAS, July, 1903.

CONTENTS.

ILLUSTRATIONS.

INTRODUCTION.

THE mining and metallurgical industries of the state during the year 1902 were conducted along the same lines previously followed, the total production aggregating over twenty-three million dollars in value (table I), by far the largest the state has ever produced. The most important developments made during the year were in coal mining operations in the northwest and in oil and gas developments in the southeast. Neither gold nor silver is yet mined in the state, although this year, as in the past, attempts have been made to create an interest in prospecting for one or both of these metals in a number of different places, the most notable of which is a continuation of prospecting begun previously in the vicinity of Galena. Although repeated assays had been made by the Geological Survey of the so-called ore from this locality, and by others, with negative results, some parties are not yet satisfied, and continue the search.

The mining of lead and zinc ores has been continued in the Galena district, with a little better results than those for the year 1901. No considerable expansion of territory has been witnessed, but, on the contrary, there has been a tendency to curtail the area of active operations.

Coal mining has been more active than ever before known, particularly in the Cherokee-Crawford county area, with a total output reaching much larger figures than for any previous year. New developments were also made in the Cretaceous area in the northwest, in Jewell county, which probably will result in a great increase in production for that part of the state.

The activities in the oil fields and gas fields were never before duplicated. The total output of oil was greatly increased, but not to so great an extent as the increase in prospecting

would indicate. This is due to two causes: one the increased prospecting being done more largely in the latter half of the year, and another the lack of capacity of the refinery at Neodesha to care for the oil. The developments were most active in the vicinity of Chanute and Humboldt, although by no means confined to these areas.

The development in brick making and the manufacture of other kinds of clay goods was increased more perhaps than any other industry. The greatest increase was in the gas region, where natural gas was used for fuel. But along with this was also a considerable increase in the production of brick, particularly paving brick, in the northeastern part of the state, where coal was used for fuel. This great increase is due principally to the general development throughout the Mississippi valley, brick being shipped to the south as far as Galveston and to the north well into the state of Nebraska.

The production of gypsum cement plaster was not quite so great as was customary in previous years. Yet the industry is in a healthy condition, and will remain a substantial industry for the state. The manufacture of Portland and hydraulic cements was considerably greater than ever before. The large Portland cement factory at Iola was unable to fill all of its orders, and probably could have sold from one-fourth to one-half more had the capacity of the mill been sufficiently increased. There was a great demand for building stone during the year, which was met by our quarrymen with very satisfactory results. The demand for large buildings produced a corresponding increase in the demand for large stone, while the extensive repair of railroad beds likewise increased the demand for stone ballast.

Salt making was confined almost entirely to Hutchinson and neighboring towns, with the greatest increase in per cent. of production at Anthony and Kingman, where extensive plants are now in operation.

The recent flood along the Kansas river valley was so extraordinary that it seemed desirable to notice it in these pages. Accordingly, a short discussion of its effects is added.

TABLE I.

SHOWING VALUE OF EACH OF THE MINERAL PRODUCTS OF KANSAS FOR 1902, AND SINCE INDUSTRY BEGAN.

NAME OF PRODUCT.	Amount for 1902.	Value per unit.	Value for 1902.	Grand total of production since industry began.
NON-METALLIC PRODUCTS.				
Coal....tons	5,230,267	$1 36	$7,139,139 35	$79,081,123 00
Coke....	53,225	2 50	133,062 50	1,006,437 50
Salt, without cooperage....bbls.	1,989,356	45	895,210 20	8,288.645 77
Cooperage (estimated)....bbls.	600,000	27	162,000 00	3,375,250 00
Clay products....	....	....	1,063,881 70	5,058,085 70
Gypsum cement plaster....tons	51,386	5 00	256,930 00	2,783,515 00
Stone, building (estimated)....cu. yds.	....	....	536,165 00	5,890,216 00
Natural gas....	....	....	939,375 00	3,360,241 00
Oil, crude....bbls.	322,023	90	289,820 70	905,565 43
Oil, refined, including gasoline and fuel oil....	159,174	2 10	334,265 40	1,750,065 00
Hydraulic cement....bbls.	....	....	77,340 50	968,629 50
Portland cement (estimated)....	650,000	1 50	975,000 00	3,025 00
Lime (estimated)....	....	....	75,000 00	1,585,000 00
Sand (estimated)....	....	....	100,000 00	1,750,000 00
METALLIC PRODUCTS.				
Zinc ore, 31,225.30 tons, worth $898,184.23, yielding metallic zinc....tons	18,735.18	96 80	1,801,265 43	49,569,570 83
Lead ore, 4,126.61 tons, worth $191,639.77, yielding metallic lead....tons	3,094.96	82 00	253,754 72	
SMELTING PRODUCTS.				
Zinc smelting....tons	87,325.50	96 80	8,453,108 40	55,853,040 63
Lead smelting....tons	1,527	82 00	125,214 00	5,687,467 38
Totals....	....	....	$23,610,532 90	$226,915,877 74

I.—GOLD AND SILVER.

Gold and Silver Ores.

THUS far in the history of the state neither gold nor silver has been found in Kansas in sufficiently large quantity to have commercial value. From time to time, ever since the earliest explorations were made, reports of discoveries of gold or silver have been sent out from many different places. Emigrants on their way across the plains in the early fifties are reported to have "panned" gold sands from the Kansas and the Arkansas rivers, and to have found some "color." But none of them found gold in sufficient quantities to justify them in stopping to prosecute mining.

Since those early days, every few years some one starts a story, first here, now there, that gold in paying quantities has been found. Usually such excitements have died in a few weeks or a few months. Occasionally they have been kept up for a year or more. Only two known to the writer, that of the Ellis-Trego district and the one in the Galena district, have survived more than two years.

The northeast part of Kansas is covered by glacial material brought down from the area of crystalline rocks in the vicinity of the Great Lakes. Included in this material are many boulders of crystalline rock which, upon partial decomposition, have generated in them much golden yellow mica in the form of little flakes. Parties unfamiliar with the properties of gold sometimes find this mica and mistake it for gold. It may be found in the rocks themselves, or in washings along streams, where such rocks have decomposed.

Many instances of this kind have occurred in which the discoverers really thought they had found gold.

During the winter of 1880, parties digging a well at Desoto

came upon such boulders about sixteen feet under the surface. A man who had spent fourteen years in gold mining in the West was called upon to pass judgment upon the discovery. He had learned that nitric acid, or "aqua fortis," as he called it, would not dissolve gold. Accordingly, he tried the yellow particles with nitric acid only to find that the acid had no effect upon them. These two tests, the color test and the acid test, were all he knew how to make, but upon their results he proclaimed to the world that he had found gold in large quantities. One very cold morning he drove to Lawrence in order to have his belief confirmed, but in reality only to have his hopes shattered. Had he been thoughtful enough to try the point of a knife blade on the yellow flakes he could have found that they were not a metal, and might have saved himself the pain of having his fondest hopes so suddenly blasted.

Since the date of the somewhat unpleasant experience of the Desoto man, many others have fared similarly. Here and there in many different places of northeastern Kansas this same golden yellow mica has been observed in connection with the granitic glacial boulders and has been mistaken for gold. Such mistakes have been made in Douglas county, in Leavenworth county, in Atchison county, in Doniphan county, and five or six others known to the writer, and probably many others about which he has never heard.

The black sands of western Kansas have disappointed many. Almost every county in the western fourth of the state has a greater or less amount of black sand concentrated in the little creeks and other places, left behind after flowing water has carried away the looser and finer grained material. Parties familiar with placer mining in California and elsewhere have learned that the black sand usually is found in placer gold mining localities. Doubtless in many places such black sand may well be taken as an indication of the presence of gold in placer sands. But in Kansas it is exceedingly doubtful about its having any value as an indication of gold. Black sand is composed of little granules of black oxide of iron, usually the magnetic oxide. This iron oxide is a normal constituent of

crystalline rocks which occur so abundantly in most gold mining localities. Gold sands are produced by the weathering away of such rocks. A portion of the rock material is rendered soluble and carried away by water. Other portions are changed into clay, which likewise is mostly carried away by surface water. But the heavier and coarser grains of quartz and some other material lodge along the hillsides or in the valleys, as in many places of the West, or possibly along ocean beaches, as at Cape Nome. Granules of metallic gold originally in quartz veins have been carried down hill or down stream with the sand and lodged wherever the sand did. Along with them quantities of black sand also may be found, as the iron oxide grains are sufficiently heavy to be dropped with the coarser sand grains. In this way they become associated with gold in gold placers.

The Great Plains area east of the Rocky Mountains is largely covered with debris carried eastward from the Rocky Mountains, and obtained from the decomposition of granites and other crystalline rocks so abundant in mountainous areas. As gold veins are moderately common in the mountains, it is reasonable to suppose some gold was carried eastward into the plains area. Wherever this detrital material was spread more or less black sand may be found along with it, which is concentrated recently in the ravines and washes of modern times.

The question now is whether or not gold was carried eastward as far as the black sand grains, that is, into western Kansas? The best way to answer this, of course, would be to make many assays of black sand, to determine whether or not gold is actually present. It is entirely possible that in extreme cases, where transporting water currents were the swiftest, some "flour gold" may have been carried 300 miles or more. A careful examination of the river sands along the Arkansas river, which rises in the vicinity of Cripple Creek, may result in the discovery of traces of gold even as far east as Wichita or Arkansas City. The sands along the Kansas river are gathered from upland material in western Kansas and eastern Colorado, which earlier was brought eastward from the great Rocky Mountain region.

They are being worked over now for the second time, and consequently would not be quite so liable to contain gold as sands in the Arkansas river. Yet it need not be surprising if here and there traces of gold were found in the sands of the Kansas river.

But the important question is: Is it probable that anywhere in western Kansas placer gold can be found in paying quantities, either in the river sands or in the sands of the general uplands? Let us see. If gold were in coarse veins in the mountains and were liberated by weathering processes wearing down the rocky vein walls and distributing the material over the Great Plains area, it is certain that the richest placers would be found close to the mountains. Universally in placer mining districts the closer one gets to the vein or lode which originally supplied the gold the richer the placers are found to be and the coarser the grains of gold. Now, the plains sand and gravel have been searched for gold in thousands of places along the eastern slope of the foot hills of the Rocky Mountains. Nowhere east of Denver and Colorado Springs has gold been found in sufficient quantity to pay expenses for operating placer mining. Is it reasonable, therefore, that the whole eastern part of Colorado would be passed over by gold carried eastward by running water in order to make rich accumulations in western Kansas? Such a process is most unlikely. Could we by some magical power determine the absolute amount of gold in all the great masses of sand and gravel now spread out over the Great Plains, doubtless it would be found that in general the farther away from the mountains the smaller would be the amount of gold. Here and there irregularities would exist on account of irregularity of water currents which carried materials eastward. The swifter the water current, the farther east gold would be carried. Therefore, it may be possible that in the Arkansas river valley traces of gold could be found, and also on the uplands in extinct river valleys. But every known fact on the nature of placer gold accumulation makes it exceedingly doubtful about much of it being found. This is strongly manifested in an eminently practical way by the many failures

made by searchers for gold who could not find it in paying quantities, even as far east as fifty miles away from the mountain ranges.

To sum up the whole matter of placer mining gold in western Kansas, then, it may be said that quite possibly minute traces of it will be found, upon careful examination, in river-valley sands, and that when so found it will be accompanied with black sand. But it is exceedingly doubtful about its ever being found elsewhere, and much more doubtful about its being found in paying quantities. Certainly it has not up to the present time.

Some years ago quite an excitement sprang up in Washington county. Newspapers gave accounts of different men on whose farms gold was discovered, of companies being organized to prospect for gold, and of fabulous prices being offered for land. Usually the accounts did not say what assayers had found gold, nor did they give detailed accounts of the manner in which gold existed. The Geological Survey obtained samples and had them carefully assayed, obtaining only negative results. In a short time the excitement passed and has not been revived since.

During the winter of 1898 and 1899 newspapers gave an account of the discovery of gold south of Galena, in the extreme southeastern corner of the state. It was reported that two practical gold mining men from Colorado were greatly impressed by the favorable appearance of the rocks, and that, upon proper assays being made, relatively large quantities of gold were discovered. Again the Survey sent for samples, and had them gathered by a number of different parties, neither one knowing what the other one was doing. A large number of samples was thus obtained and was assayed with the greatest of care and by the most approved methods, but all assays gave negative results. The excitement soon subsided, but has not yet entirely disappeared, as a few parties are still sinking shafts in a hope of finding gold.

Another reported gold discovery comes from Smith county, where certain farmers have been prospecting with the hope of

finding gold. In a few places bluffs of the chalk beds are exposed, showing calcite-filled fissures. Such fissures, as is well known, may be found almost everywhere throughout the chalk-beds area of the state. In this particular neighborhood some one reported that the calcite veins were quartz veins, and therefore it was easily surmised they carried gold. One farmer sent a number of samples to Colorado assayers and received various reports of value, rarely less than ten dollars to the ton and in extreme cases even as high as $1000. Under such conditions, it cannot be wondered that he spent the main part of one winter and a considerable amount of money in shafting and tunneling, although, had he known that quartz is hard while this calcite is soft he might have been saved the expense. Another farmer bought a horse-power drill and succeeded in sinking a hole over 400 feet deep, from which a number of different samples were sent away to be assayed, with reports returned similar to those mentioned above.

In one instance an aggregation of beautiful calcite crystals was sent to the Survey for examination, the sender, however, not being one of the landowners above referred to. Here and there on the cavity walls between the crystals golden-yellow flakes were attached to the crystals, representing gold flakes in gold-bearing quartz. The letter accompanying the shipment asked that the "gold quartz" sent might be assayed and reported upon. The first mistake, calling the calcite crystals quartz, was noticed at once and was readily detected by the cleavage of the calcite and also by its lack of hardness. The little scales were in part scraped off and treated with acid, whereupon they dissolved readily, while had they been gold such an acid would not have dissolved them. But in order to place the question beyond the possibility of a doubt the remaining material was carefully assayed, with the expected result, not even a trace of gold, making it quite evident that the flakes were of ordinary gilding which had been applied with a brush.

A word further might here be added to the question of gold in the shales of western Kansas, although since the publication

—2

of Doctor Lindgren's report,* it would seem almost unnecessary.

During the spring of 1902, at the request of interested parties, in company with two gentlemen of high standing, one a scientist and one a business man living in an adjoining state, the writer visited the district in question and gathered eleven samples from what were supposed to be the best localities. He took with him drills, picks, and blasting powder, and wherever necessary blasted fresh material to obtain the samples. The two gentlemen named above then properly sampled the material, wrapped it in eleven different packages, and the business man, the non-resident of Kansas, took them and sent them to eleven different assayers here and there throughout the entire United States; one of the samples reached as far east as the Atlantic ocean and another as far west as the Pacific, with the other nine distributed between these extreme points. Six of the assayers chosen were professors of mining or metallurgy in six of the best mining schools of America, the other five being practical assayers conducting commercial assay offices. From these, ten reports came finding no gold whatever, or, if any, only a mere trace. The eleventh one reported two dollars to the ton. As this sample was the same as samples sent to other assayers who reported nothing, it became desirable to learn why one should report two dollars and the others nothing. Accordingly, letters were sent asking that whatever residual pulp was on hand be returned. Two assayers responded by sending back enough material to have other assays made. After waiting a few weeks these two samples were crossed and sent to the two assayers who returned them. Again the assayer who first reported gold reported finding sixty cents to the ton in the material first assayed by the other party, while the material said to contain two dollars to the ton was promptly reported back by the second assayer as containing nothing whatever. Why this discrepancy of reports each reader must answer for himself.

It is not a pleasant task continuously to be insisting that Kansas has no gold, while so many assayers and would-be scientists

* Bulletin 202, U. S. Geological Survey, Washington, D. C.

are persistently claiming that gold in almost fabulous richness is found. Yet the citizens of Smith county and other parts of the state deserve protection from assayers who make favorable reports only to encourage their customers in sending additional materials, in order that the mere pittance of assay fees may be collected. It is safe to say that not a single sample of Smith county material has ever been correctly reported upon, provided such a report stated that gold existed in the sample in sufficient quantity to be made a paying proposition, even under the most favorable conditions of mining and milling operations. Ever since its organization this Survey has witnessed excitements of this kind, due either to ignorance of actual existing conditions or to wilful misrepresentation. Statistics cannot be obtained showing the total amount of money spent in prospecting on account of such false reports. It would aggregate, doubtless, many thousands of dollars. But the worst feature is that innocent landowners are misled, false hopes are created, and, to a great extent, such landowners are largely disqualified for their ordinary business occupations, or at least are interrupted for years, so that much time is lost. The writer is acquainted with families whose hopes are blasted and whose lives have been made miserable by such procedures. It would certainly seem that the time has come when all good citizens should join in putting a stop to such procedures, even, if necessary, by following the example of some other states in enacting stringent laws against false assayers.

Gold and Silver Smelting.

During the year 1902 the Cherokee-Lanyon Zinc Company, at Iola, erected a small furnace for extracting gold and other valuable metals from the residue taken from the retorts in zinc smelting. This, it is understood, was somewhat in the line of experimenting, and should it have proven successful the plant would have been enlarged from time to time as the demand required. It was brought about on account of the shipment of western ores to the Iola furnaces. Zinc ores containing values

in gold, silver and copper have appeared in large quantities at these smelters, brought from many different places. Since the closing down of the refinery at Argentine, this was the only gold and silver furnace in the state. In a letter just received from the Cherokee-Lanyon Company they state that the experiment showed that the ores did not carry sufficient values in the precious metals to equal the expense of extraction, and that the furnace, therefore, was closed permanently.

II.—LEAD AND ZINC.

DURING the year 1902 Kansas produced a little less zinc ore than in the year 1901, the figures being 31,225 tons for 1902 and 33,977 for 1901. The price, however, was higher, making the net total value for 1902 surpass that of 1901 about $100,000. The average price throughout the year for 60-per-cent. ore was about $32 per ton, against $27.95 for 1901.

There was a slight falling off in the production of lead ore also, the yield for 1902 being 4,126.61 tons, against 5,230.13 for 1901. Here there was a slight decrease in the price, the average price per ton for the lead ore in 1902 being $44.26, and $46.44 in 1901. But the increased price of zinc ore raised the total value for the two ores to $1,089,824, while the value for 1901 was only $1,043,725.

Table II shows the monthly production of zinc ore and lead ore in the Galena district, with price per ton of same, and also the monthly production for the entire Kansas-Missouri area, and the per cent. which the Kansas production is of the whole. A comparison of this table with similar tables published in previous years shows that recently the per cent. of the whole product in Kansas territory has gradually declined. In 1902 this per cent. was 13.64 for lead ores and 11.99 for zinc ores; in 1901 it was 14.92 for lead ores and 13.34 for zinc ores; in 1900 it was 17.22 for lead ores and 18.30 for zinc ores; in 1899 it was 27.48 for lead ores and 24.24 for zinc ores; in 1898 it was 32.63 for lead ores and 33.28 for zinc ores, beyond which the statistics have not been computed. This decrease in per cent. is due in part to an actual decrease in the amount of ore produced, and in part to the increased production of Missouri mines.

TABLE II.

SHOWING AMOUNT AND VALUE OF ZINC ORE AND LEAD ORE IN THE GALENA AREA
compared with amount and value of same ores for the whole Galena-Joplin area, 1902.
Data gathered from reports in *Engineering and Mining Journal.*

MONTH.	Product and value of Kansas area in 1902.					Product and value in Kansas and Missouri area in 1902.					Per cent. Kansas production of whole area, 1902.	
	Zinc ore. In tons (2000 lbs.) and dollars.		Lead ore. In tons (2000 lbs.) and dollars.		Total value.	Zinc ore. In tons (2000 lbs.) and dollars.		Lead ore. In tons (2000 lbs.) and dollars.		Total value.		
	Product.	Price.	Product.	Price.		Product.	Price.	Product.	Price.		Zinc ore.	Lead ore.
January	2,465.68	$27 00	311.09	$42 00	$78,958	20,123.48	$27 00	2,705.79	$12 00	$666,133	12.22	11.49
February	2,157.73	27 50	214.23	43 50	67,133	19,307.89	27 50	2,178.83	43 50	695,889	11.19	9.83
March	3,125.55	29 50	410.54	43 26	96,579	26,925.58	29 50	3,183.97	43 26	794,823	11.60	12.89
April	2,813.45	31 40	310.22	43 50	89,074	20,860.89	31 40	3,015.62	43 50	782,151	13.48	10.28
May	3,404.66	30 00	353.14	44 10	108,547	27,044.75	30 00	3,065.89	44 10	920,199	12.59	11.52
June	2,787.10	32 50	299.59	45 35	102,343	20,335.23	32 50	1,928.30	45 35	706,699	13.78	15.53
July	2,338.45	37 00	235.77	48 20	85,217	21,870.83	37 00	2,622.54	48 20	862,184	10.69	8.99
August	3,029.83	35 25	385.78	49 00	109,618	24,872.85	35 25	2,729.07	49 00	931,812	12.43	14.13
September	2,290.00	34 00	492.99	49 00	92,671	19,719.87	34 00	2,712.12	49 00	756,844	11.61	18.15
October	2,232.98	35 25	408.86	49 37	91,711	20,692 87	35 25	2,284.85	49 37	810,606	10.79	17.89
November	2,276.86	33 50	420.28	50 00	92,211	19,525.78	33 50	2,823.09	50 00	758,866	11.66	14.88
December	2,303 01	31 00	284.12	50 00	75,762	19,460.49	31 00	2,329.43	50 00	688,878	11.83	12.19
Totals and averages,	31,225.30	$32 00	4,126.61	$46 44	$1,089,824	260,239.01	$32 00	31,579.50	$46 44	$9,323,579	11.99	13.64

TABLE III.

SHOWING OUTPUT OF ZINC AND LEAD ORES, GALENA DISTRICT, KANSAS.

From January 1, 1886, to December 31, 1902, inclusive. Data since 1895 from the *Engineering and Mining Journal;* others from Mr. Russell Elliott, Galena.

YEAR.	Zinc Ore.			Lead Ore.			Total value of output.
	Tons (2000 lbs.)	Average price per ton, 60% ore.	Value.	Tons (2000 lbs.)	Average price per ton.	Value.	
1886 ..	31,768.00	$18 50	$587,708 00	2,962.14	$59 00	$174,766 38	$762,474 38
1887 ..	32,795.00	19 00	623,105 00	3,073.19	52 50	161,499 98	784,604 98
1888 ..	33,391.00	21 00	701,211 00	2,624.00	31 00	81,344 00	782,555 00
1889 ..	32,950.00	24 00	790,800 00	3,992.50	46 00	183,655 00	974,455 00
1890 ..	21,675.00	23 00	498,525 00	4,173.96	42 28	176,176 28	674,701 28
1891 ..	20,641.00	21 51	454,102 00	3,602.21	50 82	182,271 83	636,373 83
1892 ..	23,811.00	20 00	476,237 78	7,188.17	42 00	301,903 14	778,140 92
1893 ..	25,028.00	18 85	471,789 00	5,139.59	38 00	195,314 42	667,103 42
1894 ..	28,670.00	17 10	490,257 00	5,817.49	33 64	195,794 56	686,051 66
1895 ..	41,282.00	19 68	812,792 00	12,537.64	38 56	482,548 75	1,295,340 75
1896 ..	62,232.00	22 51	1,401,307 83	14,061.58	32 04	450,529 90	1,851,837 73
1897 ..	59,451.00	25 17	1,492,663 04	15,184.68	50 20	762,469 96	2,255,183 00
1898 ..	74,852.00	26 64	1,994,230 55	7,918.28	42 04	352,798 45	2,347,029 00
1899 ..	64,708.48	38 54	2,313,831 00	6,723.40	52 62	354,311 00	2,668,142 00
1900 ..	46,501.35	30 28	1,238,237 13	4,938.44	48 80	240,995 87	1,479,233 00
1901 ..	33,977.80	27 95	797,844 37	5,238.19	46 94	245,880 63	1,043,725 00
1902 ..	31,225.30	32 00	898,184 23	4,126.61	46 44	191,639 77	1,089,824 00
Totals for 17 years..	664,908.93	$22 69	$16,042,824 93	109,805.07	$44 26	$4,733,900 02	$20,276,724 95

Table III gives an exhibition of the total production by years of the Kansas mines, beginning with the year 1886. It will be noticed that the largest production of lead ore was in 1897, and the largest production of zinc ore in 1898, since which dates the production of each ore has greatly decreased.

LEAD ORE AND ZINC ORE MINING.

Galena District.

The geography of the mining operations during the past year in the Galena district is almost the same that it has been for the last five years, with a tendency, if any change is recorded, to a concentration of the area by a curtailment of the outlying camps. No new mines of any considerable note have been developed, and no new areas have been opened up. Still, quite a number of new shafts have been sunk and new ore bodies dis-

covered. One quite interesting instance of this kind is the discovery of a large body of shallow zinc ore on the east side of Spring river to the northeast of the Badger mines.

Lead and Zinc Ores in Other Parts of the State.

Another year has passed without lead ores or zinc ores being found in paying quantities in Kansas outside the Galena district. This has been commented upon in different issues of this report. Quite a number of additional "finds" have been made in various places in the Coal Measures and westward into the Flint Hills. Such discoveries are of small fragments or crystals of zinc blende or galena, and frequently excite considerable curiosity, as many people are lead thereby to hope for larger discoveries.

The extensive distribution of lead ores and zinc ores throughout the Coal Measures of Kansas is very remarkable. In some places the ores are found in limestone, in others in concretionary masses in the shales, and still again in the shales themselves. It seems that conditions have been favorable in some respects for the extensive accumulation of these ores over very wide areas, but other necessary conditions evidently were absent, resulting in the formation of such small quantities of ores over such wide areas.

Price of Lead Ores and Zinc Ores.

Throughout the year 1902 the price of zinc ores was tolerably constant, with the exception of a period of high prices during July and August. For January the average for 60 per cent. ore was about $27 per ton, which increased to $27.50 in February, $29.50 in March, $31.40 in April, a decline to $30 for May, then an increase to $32.50 in June, $37 in July, $35.25 in August, $34 in September, $35.25 again in October, $33.50 in November, and $31 in December, making an average of $32 for the entire year. This is about $4 a ton higher than the prices for the year preceding.

It will be noted that a variation in the price of spelter followed pretty closely those in the price of ore. By referring to table IV such a comparison may be made, New York prices

TABLE IV.

SHOWING COMPARATIVE VALUES PER TON (2000 LBS.) OF ORES IN GALENA-JOPLIN AREA AND METALLIC PRODUCTS IN NEW YORK.

MONTH.	ZINC.									
	1898.		1899.		1900.		1901.		1902.	
	Ore.	Spelter.	Ore.	Spelter.	Ore.	Spelter.	Ore.	Spelter.	Ore.	Spelter.
January ...	$23 25	$79 20	$40 25	$106 80	$35 13	$93 00	$27 00	$82 60	$27 00	$85 40
February ..	22 62	80 80	43 37	125 60	34 50	92 80	27 25	80 20	27 50	83 00
March	22 50	90 00	43 40	126 20	32 60	92 00	27 20	78 20	29 50	85 60
April	27 30	85 20	51 50	133 40	32 88	94 20	28 38	79 60	31 40	87 40
May	25 50	85 40	50 50	137 60	30 63	90 60	28 38	80 80	30 00	89 40
June.......	28 00	95 40	45 50	119 60	27 80	85 80	27 80	79 80	32 50	99 20
July	27 90	93 20	44 20	116 40	27 50	85 60	26 65	79 00	37 00	105 40
August	27 00	91 60	45 00	113 00	28 38	83 40	26 87	79 80	35 25	108 80
September,	30 50	93 40	43 75	110 00	27 70	82 20	26 25	81 60	34 00	109 80
October....	24 40	99 60	48 50	106 40	28 50	83 00	28 00	84 60	35 25	107 60
November..	34 75	105 80	35 00	92 80	28 88	85 80	29 00	85 80	33 50	103 60
December..	36 10	102 00	36 00	93 20	28 95	85 00	31 62	85 75	31 00	95 60
Averages,	$27 49	$91 80	$43 50	$115 08	$30 29	$87 80	$27 87	$81 48	$32 00	$96 80

MONTH.	LEAD.									
	1898.		1899.		1900.		1901.		1902.	
	Ore.	Pig lead.	Ore.	Pig lead.	Ore.	Pig lead.	Ore.	Pig lead.	Ore.	Pig lead.
January ...	$44 00	$73 00	$47 88	$83 60	$55 50	$93 60	$55 66	$87 00	$42 00	$80 00
February ..	43 50	74 20	53 00	89 80	55 38	93 50	45 00	87 00	43 50	81 50
March	46 24	74 40	51 60	87 40	54 90	93 50	46 30	87 00	43 26	81 50
April	43 20	72 60	44 50	86 20	54 12	93 50	45 62	87 00	43 50	81 50
May	43 50	72 80	52 00	88 80	51 50	83 62	46 00	87 00	44 10	81 50
June.......	45 74	76 40	52 00	88 60	43 10	78 02	47 30	87 00	45 35	81 50
July	45 20	79 00	53 80	90 40	45 24	80 60	47 26	87 00	48 20	81 50
August	46 12	80 00	54 50	91 40	46 12	85 00	47 00	87 00	49 00	81 50
September,	47 00	79 80	54 00	91 60	45 80	87 00	46 12	87 00	49 00	81 50
October....	46 90	75 60	53 80	91 50	46 00	87 00	46 50	87 00	49 37	81 50
November..	42 16	74 00	54 40	91 50	46 00	87 00	46 50	87 00	50 00	81 50
December..	40 00	75 20	54 00	92 80	46 00	87 00	44 00	84 02	50 00	81 50
Averages,	$44 46	$75 58	$52 12	$89 47	$49 14	$87 45	$46 94	$86 75	$46 44	$81 38

being used. In January the price of spelter per ton was $85.40, with a drop to $83 for February, although the price of ore was advanced. In March it was $85.60, just barely above the January price, although ore was $2.50 a ton higher; then to $87.40 in April, $89.40 in May, $99.20 in June, $105.40 in July, $108.80 in August, and $109.80 in September, which is quite at variance with the prices of ore. The October price was $107.60, with $103.60 for November, and $95.60 for December, giving an average of $96.80 for the year, which is over $15 a ton higher than the average price of spelter during 1901. It is difficult to deny that the price of spelter has a strong influence on the ore market, and yet it must be confessed that it does not entirely control it.

In this connection the reader is referred to table V, wherein is shown, in column 1, the price per ton of 60 per cent. ore at the mines; the price per ton of spelter in New York, in column 2; the ratio between these two values, in column 3; the price per ton of zinc in 60-per-cent. ore before it is smelted, in column 4, not allowing anything for loss; and finally, in column 5, the total margin per ton of spelter, which margin must cover all losses in smelting, expenses of buying and shipping the ores, cost of smelting, and profits on the smelting business. Columns 3 and 5 are the important ones. In the former it will be noted that the ratio between the price of a ton of ore and a ton of spelter begins in 1886 at 1 to 4.69, which gradually increases to 1891, when it is 1 to 5.05. From 1891 to 1900 this ratio gradually decreases, until, for the latter year, it is 1 to 2.89. For the year 1902, this ratio increases to 1 to 3.025, implying that the price of ore was lower compared with spelter than it was during 1901. Column 5 shows practically the same results. The margin for expenses and profit in the smelting business began in 1886 with $57.07, which margin increased to the year 1891, when it reached the large amount of $72.97. From here it gradually decreased, with but little interruption, to 1899, to $50.77 per ton, from which point it fell to $34.92 in 1901, the lowest point reached in the entire period, but advanced again to $43.47 in 1902. With the

TABLE V.

SHOWING PRICE PER TON OF ZINC BLENDE AT GALENA-JOPLIN

From 1886 to 1902, inclusive, and price per ton of metallic zinc in New York, with ratio between the two; also, price per ton of metallic zinc in 60-per-cent. zinc ore and difference between this and New York price.

YEAR.	Price per ton of zinc blende in Galena-Joplin. (2000 lbs.)	Price per ton of metallic zinc in New York. (2000 lbs.)	Ratio between price of zinc blende and metallic zinc.	Price per ton of metallic zinc in 60-per-cent. ore. (2000 lbs.)	Difference between price per ton of zinc in 60-per-cent. ore and New York price.
1886.........	$18 50	$87 90	1:4.69	$30 83	$57 07
1887.........	19 00	92 80	1:4.88	31 67	61 13
1888.........	21 00	98 34	1:4.68	35 00	63 34
1889.........	24 00	100 20	1:4.17	40 00	60 20
1890.........	23 00	108 75	1:4.72	38 33	70 42
1891.........	21 51	108 82	1:5.05	35 85	72 97
1892.........	20 00	89 78	1:4.48	33 33	56 45
1893.........	18 85	80 37½	1:4.28	31 42	48 95
1894.........	17 10	70 43	1:4.09	28 17	41 26
1895.........	19 68	71 04	1:3.60	32 80	38 24
1896.........	22 51	79 70	1:3.54	37 45	42 25
1897.........	25 17	82 40	1:3.27	41 82	40 58
1898.........	27 63	91 40	1:3.30	46 05	45 35
1899.........	38 54	115 00	1:2.98	64 23	50 77
1900.........	30 28	87 80	1:2.89	50 47	37 33
1901.........	27 95	81 50	1:2.91	46 58	34 92
1902.........	32 00	96 80	1:3.025	53 33	43 47
Averages for 17 years....	$23 92	$90 77	1:3.915	$39 84	$50 86

margin as low as it was in 1901 it was impossible for the coal smelters to operate, and it is doubtful if they could have avoided a loss in 1902, although the margin was advanced.

There is a perpetual contest between the ore producers on the one hand and the smelters or ore buyers on the other. In early days the ore producers had no organization and worked entirely independently. It is quite probable that zinc smelting was more expensive than it is now, particularly since the smelters have moved to the gas fields. But this also proves that the marginal profits must have been much greater. The combination effected by the ore producers doubtless has had a great deal to do with forcing ore prices up and compelling ore buyers to have some regard to the current prices of spelter.

Zinc Smelting.

During the year 1902 the output of our zinc smelters reached 87,325.5 tons, higher figures than ever before reached in the history of the state. Table VI exhibits the amount and value of spelter produced in Kansas annually from 1882 to 1902, inclusive, a period of twenty-one years. It will be seen that, with the slight reversals of 1888 and 1896, the annual output of spelter has gradually increased throughout this entire period. Beginning in 1882 with 7366 tons, we now have more than ten times the amount, and an aggregate for the entire period of nearly 600,000 tons of spelter. The value of this product for 1902 was $8,453,108.40, and the value of the total production since zinc smelting began reaches the enormous sum of $55,-853,040.63.

TABLE VI.

SHOWING AMOUNT AND VALUE OF METALLIC ZINC PRODUCED AT KANSAS SMELTERS, 1882 to 1902, INCLUSIVE.

Price per ton in New York.

(Data 1882 to 1896 from United States Geological Survey statistics.)

YEAR.	Amount in short tons (2000 pounds).	Price per ton in New York.	Total value.
1882..........	7,366	$110 60	$814,679 60
1883..........	9,010	90 60	816,306 00
1884..........	7,859	89 60	704,466 40
1885..........	8,502	86 80	737,973 60
1886..........	8,932	87 90	785,122 80
1887..........	11,955	92 80	1,109,424 00
1888..........	10,432	98 34	1,025,902 88
1889..........	13,658	100 20	1,368,531 60
1890	15,199	108 75	1,652,891 25
1891..........	22,747	108 82	2,475,336 96
1892....	24,715	89 78	2,218,912 70
1893..........	22,815	80 37½	1,733,755 63
1894..........	25,588	70 43	1,902,162 84
1895..........	25,775	71 04	1,831,056 00
1896..........	20,759	79 70	1,653,592 30
1897..........	33,443	82 40	2,755,703 20
1898..........	38,543	91 40	3,508,524 27
1899..........	52,664	115 00	6,056,360 00
1900..........	57,876	87 80	5,028,832 80
1901..........	81,542.3	81 50	6,645,697 45
1902.........	87,325.5	96 80	8,453,108 40
Totals.. ...	586,705.8	....	$53,278,040 63
Estimation of zinc smelted previous to 1882.................................			2,575 000 00
Grand total.............................			$55,853,040 63

TABLE VII.

SHOWING WORLD'S PRODUCTION OF METALLIC ZINC FROM 1884 TO 1902, INCLUSIVE.

From Nineteenth Annual Report Director United States Geological Survey, part VI, pp. 223 and 224; foreign figures reported by Henry M. Merton & Co., London, England. Figures since 1898 from *Engineering and Mining Journal.*

YEAR.	Rhine district and Belgium.	Silesia.	Great Britain.	France and Spain.	Austria.	Poland.	Total foreign.	America.	Grand total.	Per cent. American.
1884	127,240	76,116	29,259	15,341	6,170	4,164	260,290	34,414	294,704	8.56
1885	129,754	79,623	24,299	14,847	5,610	5,019	259,152	36,329	292,659	8.05
1886	129,020	81,630	21,230	15,305	5,000	4,145	256,330	38,072	294,402	12.93
1887	130,995	81,375	19,839	16,028	5,388	3,580	257,155	44,946	302,101	14.87
1888	133,245	83,375	26,783	16,140	4,977	3,785	268,305	49,913	318,218	15.68
1889	134,648	85,665	30,806	16,785	6,330	3,026	277,248	52,553	329,801	16.23
1890	137,630	87,475	29,145	18,240	7,135	3,620	283,245	57,860	341,105	16.96
1891	139,695	87,080	29,410	18,360	6,440	3,760	284,745	72,208	356,953	20.22
1892	143,305	87,760	30,310	18,662	5,020	4,270	289,327	77,910	367,237	21.21
1893	149,750	90,310	28,375	20,585	7,560	4,530	301,110	70,385	371,495	18.93
1894	152,420	91,145	32,065	21,245	8,580	5,015	310,470	67,257	377,727	17.80
1895	172,135	93,620	29,495	22,895	8,355	4,960	331,460	80,077	411,537	19.45
1896	179,730	95,875	25,880	28,450	9,255	6,165	345,355	72,767	418,122	17.43
1897	184,455	94,045	23,430	32,120	8,185	5,760	347,995	89,268	437,263	20.41
1898	191,836	99,233	27,635	32,649	7,229	5,664	364,246	103,515	467,761	22.10
1899	192,994	100,160	32,223	33,482	7,305	6,325	372,496	123,194	495,690	26.87
1900	189,994	102 316	30,307	44,200	6,836	5,969	288,525	122,885	411,375	29.86
1901	223,199.2	119,151.2	32,692.8	30,536.8	8,624	6,647.2	420,851.2	140,822	561,673.2	25.07
1902	220,616	127,074	44,361.3	29,795	8,744 4	8,983	439,603.7	158,237	597,840.7	26.47

During the year 1902 a new smelter was established at Neodesha, under the firm name of Lanyon Brothers Spelter Company. Some of the smelters at Iola were considerably enlarged, notably those of the Lanyon Zinc Company and the Geo. A. Nicholson Company. Also the Lanyon Zinc Company began the erection of rolling mills in La Harpe, and the United Zinc and Chemical Company, of Kansas City, began the erection of a combined zinc smelting and sulphuric acid factory at Iola, each of which was almost ready for operation at the close of the year.

The World's Production of Metallic Zinc.

Table VII shows the world's production of metallic zinc from 1884 to 1902, inclusive, with the total American production. It will be noted from this table that the world's production has increased, and that the relative per cent. of American production is likewise increased. The consumption of spelter, of course, keeps pace with the production. The comparatively high price of 1902 implies a great consumption, for had consumption materially dropped below production prices certainly would have declined.

Spelter has now reached a permanent position in the list of useful and important metals, and for a number of years has ranked fifth in the value of the total metallic production of the United States.

The Spelter Market.

The spelter market for the year is well illustrated in table VIII, which gives the monthly and yearly market price of spelter from 1893 to 1902, inclusive.

TABLE VIII.

SHOWING AVERAGE MONTHLY AND YEARLY PRICE OF METALLIC ZINC—"SPELTER"—IN NEW YORK FROM 1893 TO 1902, INCLUSIVE.

(Partly from *Engineering and Mining Journal.*)

YEAR.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	cts.	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*
1893.............	4.39	4.39	4.28	4.38	4.41	4.27	4.13	3.89	3.69	3.68	3.65	3.80	**4.08**
1894.............	3.56	3.85	3.89	3.62	3.37	3.40	3.43	3.38	3.44	3.45	3.36	3.43	**3.52**
1895.............	3.28	3.20	3.23	3.30	3.50	3.65	3.75	4.15	4.30	4.10	3.55	3.49	**3.63**
1896.............	3.75	4.03	4.20	4.09	3.98	4.10	3.97	3.76	3.60	3.72	3.99	4.14	**3.94**
1897.............	3.91	4.02	4.12	4.13	4.21	4.21	4.32	4.26	4.18	4.17	4.03	3.89	**4.12**
1898.............	3.96	4.04	4.25	4.26	4.27	4.77	4.66	4.58	4.67	4.98	5.29	5.10	**4.57**
1899.............	5.34	6.28	6.31	6.67	6.88	5.98	5.82	5.65	5.50	5.32	4.64	4.66	**5.75**
1900.............	4.65	4.64	4.60	4.71	4.53	4.29	4.28	4.17	4.11	4.15	4.29	4.25	**4.39**
1901.............	4.13	4.01	3.91	3.98	4.04	3.99	3.95	3.99	4.08	4.23	4.29	4.29	**4.07½**
1902.............	4.27	4.15	4.28	4.37	4.47	4.96	5.27	5.44	5.49	5.38	5.18	4.78	**4.84**
Av. for 10 yrs.,	4.13	4.26	4.31	4.35	4.37	4.36	4.36	4.33	4.31	4.32	4.23	4.18	**4.29**

III.—COAL IN KANSAS.

THE year 1902 was the most prosperous ever known for coal mining in Kansas, if we measure prosperity by the total production and aggregate value of product. The total production for the year is 5,230,267 tons, which had an average market value at the mine of $1.36, yielding $7,139,139.35.

Crawford county still continues to lead the other counties in production, with Cherokee county a close second. These two counties combined produce more than four-fifths of the total product of the state. Leavenworth and Osage counties come next, with Leavenworth decidedly in the lead this year; then follow fourteen or fifteen other counties which yield a small amount of coal, principally consumed by the wagon trade, but when favorably located with reference to railroads they ship small amounts by rail. Linn county has such a mine beside the Missouri Pacific track, two and a half miles east of Pleasanton. Franklin county has two such mines—one located on the Santa Fe track at Ransomville, and another at Pomona.

Almost all the coal of the state comes from the Coal Measures, the single exception being the soft Cretaceous coal mined in small quantities in the west-central part of the state, in Republic, Jewell, Cloud, Mitchell, Lincoln and Ellsworth counties. Within the Coal Measures, the Cherokee shales are the most productive, supplying all the coal from Cherokee, Crawford, Bourbon, Labette and Leavenworth counties. Table X shows the production by geological formations. It will be seen that the Cherokee shales produce over 95 per cent. of the total state production for 1902. Next above the Cherokee shales we have the Pleasanton shales, which produce the coal of Linn county; still higher up, the Lawrence shales, which produce the Franklin county coal; and above these the Osage shales,

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producing the coal of Osage county at Osage City, Scranton, Carbondale, Burlingame, and a large number of other points where but little coal is mined, but which form a line of mines extending entirely across the state from north to south. The Osage shales are about 2000 feet above the base of the Cherokee shales, making their coal about 1800 feet above the Cherokee-Crawford county coal-beds.

The coal of Cretaceous age in Kansas is poor in quality and thus far the output is quite limited in quantity. Almost no prospecting has been done for it excepting along the line of outcropping. During the winter of 1901–'02 a drill hole was put down for other purposes near Jewell City, in the southeast corner of Jewell county. It started in the overlying Benton formation, but soon reached the Dakota coal-bearing shales, and at a depth of 162 feet a seam of coal nearly three feet in thickness was discovered, which in quality is better than other Cretaceous coal previously mined in the state. A shaft was sunk and mining operations begun, which have already resulted in the production of a few thousand tons, sold to the local wagon trade. Quite likely similar prospecting elsewhere might develop Cretaceous coal which would prove to be better than that found along the outcropping lines.

Table IX shows the annual coal production from 1880 to 1902, inclusive. It may be noted that, with the single exception of 1893, each year has witnessed a substantial increase in the production over any preceding one. The total production for the state to the close of 1902 aggregates 61,917,555 tons, with a value of $79,081,123.35, surpassing the value of any other single mineral product.

TABLE IX.

SHOWING COAL PRODUCTION IN SHORT TONS (2000 LBS.), 1880 TO 1902, INCLUSIVE

With price per ton and value of yearly product.

YEAR.	Production in short tons (2000 pounds).	Price per ton.	Value of yearly product.
1880 *	550,000	$1 30	$715,000
1881 *	750,000	1 35	1,012,300
1882 *	750,000	1 30	975,000
1883 *	900,000	1 28	1,152,000
1884 *	1,100,000	1 25	1,375,000
1885	1,440,057	1 23	1,770,270
1886	1,350,000	1 20	1,620,000
1887	1,570,079	1 40	2,198,110
1888	1,700,000	1 50	2,550,000
1889	2,112,166	1 48	3,126,005
1890	2,516,054	1 30	3,170,870
1891	2,753,722	1 31	3,607,375
1892 *	3,007,276	1 31½	3,954,568
1893	2,881,931	1 37½	3,960,331
1894	3,611,214	1 35⅝	4,899,774
1895	3,190,843	1 12½	3,590,141
1896	3,191,748	1 01⅛	3,227,357
1897	3,291,806	1 07	3,488,380
1898	3,860,405	1 08½	4,193,159
1899	4,096,895	1 25	5,124,248
1900	4,269,716	1 28	5,500,709
1901	4,793,374	1 30	6,231,386
1902	5,230,267	1 36	7,139,139
Totals	58,917,553	$1 28	$74,581,123
Output previous to 1880	3,000,000	1 50	4,500,000
Grand totals	61,917,553	....	$79.081,123

* Figures for 1880 to 1884, inclusive, and 1892, taken from United States Geological Survey reports. All others taken from reports of State Inspector of Coal-mines.

IV.—OIL AND GAS IN KANSAS.

THE year 1902 witnessed greater activity in the production of oil and gas than any other year in our history. A larger volume of business was done, particularly a larger amount of development work.

OIL.

The older oil fields of Neodesha, Thayer and Buffalo have witnessed no material changes. The Prairie Oil Company drilled a number of new wells and abandond a few old ones. There has been a great activity in oil development in the vicinity of Chanute and Humboldt. The Neosho river valley from Chanute to Humboldt, with portions of adjoining uplands, is now the site of scores of producing oil wells, with development work increasing rapidly every week. The first productive wells in this territory were obtained by Mr. I. N. Knapp in the river valley just east of Chanute. Late in 1901 other parties came in, obtained leases, and began prospecting in the valley north of Mr. Knapp's holdings. Almost every well proved successful, reports on each were scattered far and wide, with a result that by April, 1902, quite a number of other companies were on the ground, some local, but most of them from outside, each one obtaining leases and drilling. More than three-fourths of the wells drilled in the river valley to the north and northwest of Chanute have proved successful, and many others on the uplands between Chanute and Humboldt, and to the north of Humboldt likewise, are oil producers.

During the same time that Chanute and Humboldt were witnessing such activities in development work other places near by were also active. Cherryvale became an oil producer on a small scale, with good indications of a healthy development. Oil

was found on the high hills to the north of town and already a nice bunch of derricks are standing.

Peru, in Chautauqua county, assumed renewed activity, and bids fair to become an oil center. Years ago Mr. Geisser obtained leases and drilled a number of wells in and around Peru, some of which yielded good flows of gas, while others were oilers. During the summer of 1902 he sold his holdings to the company, retaining an interest in the property and continuing as manager. Many new wells were drilled, gas was piped to Sedan, and other improvements made.

Montgomery county also took renewed activity. New oil-wells were drilled at different places, particularly in the southwest part near Caney and elsewhere, so that it now seems this county may be counted an oil county. It has long been known as prominent gas territory.

The refinery at Neodesha when first built had a capacity of 500 barrels per day. With the new discovery of such large quantities of oil work was begun to enlarge it to double its original capacity. A pipe line has existed for years from Neodesha northeast to Thayer, about fifteen miles away. This line is now extended from Thayer to Chanute, fifteen miles farther. Before completing the pipe line the Standard Oil Company put up a 35,000-barrel tank at Chanute which was soon filled with oil, and was connected onto the new pipe line to the refinery at Neodesha about the middle of December, 1902. Mr. Knapp has been shipping regularly by rail throughout the year to Kansas City and other markets.

It is impossible to determine accurately the amount of oil produced in the state during the year. Many of the wells are closed in, awaiting a market, while many others have small tanks built adjacent to the wells, all of which are now full. A conservative estimate would place the amount actually marketed as great as 322,000 barrels, which is more likely to be too small than too large. The price has varied considerably during the year, but probably has averaged about ninety cents per barrel, which would give a total valuation for the state of over $289,000, as shown in table XI.

GAS.

There has been a great development of gas in the state during the year 1902. The Iola district still maintains the lead in consumption, as a larger number of big factories are located there than at any other one place. Development work has been active in the Iola fields, with very encouraging results. It is now known that the field extends farther north, south and west than previously considered. In May Mr. Noble brought in a six-million gas-well about a mile farther north than it had previously been supposed gas could be found. A number of other strong wells were found across the Neosho river to the southwest, and also to the south and southeast of the Iola Portland cement works. In the vicinity of Chanute large quantities of gas have been found in previously unexplored territory. About six miles west of Chanute Colonel O'Neil brought in a strong well which has not been measured accurately, but which seems to be at least a ten million well. Prospecting has been carried to the east of Chanute also, and a strong well has been found about eight miles east and a little north of that place.

In Montgomery county the greatest development has been in the vicinity of Bolton, seven or eight miles southwest of Independence. This field has been known for some time, but has produced so many strong wells during the past year that a number of experienced gas men are now speaking of it as the strongest field in the state.

A very important discovery was made at Moline, in the southern part of Elk county, where a strong gas well was obtained about twenty miles farther west than gas had previously been known. A number of other lesser developments have been made at many different places here and there throughout the gas fields. It is safe to say that at the present time there is fully twice as much gas "in sight" as ever before in the history of the state.

The latest and most surprising discovery was made at Winfield, in Cowley county, within a few miles of the Arkansas river. This is the first discovery of gas thus far reported west of the Flint Hills area, and is about fifty miles west of the well

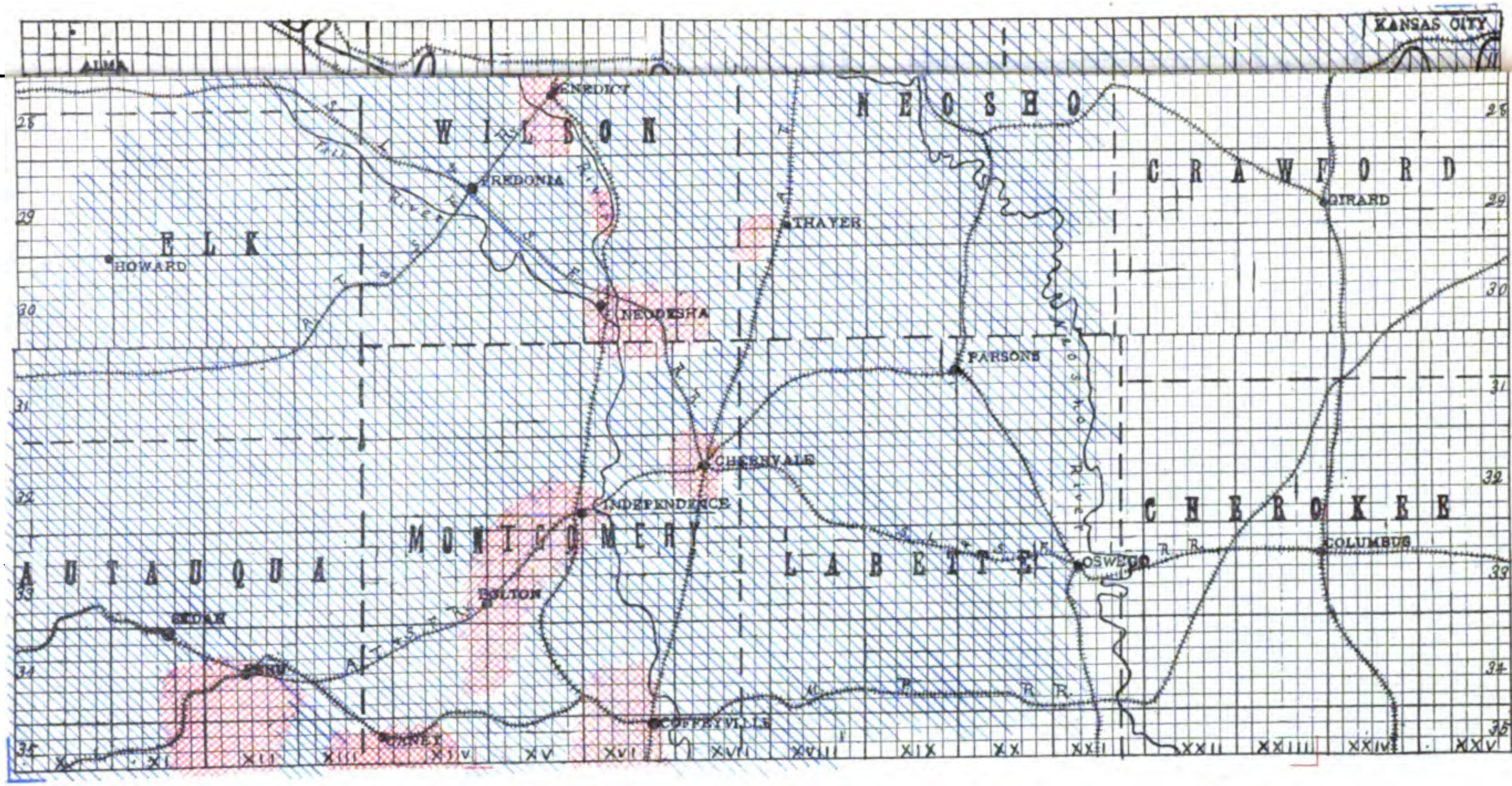
proven gas territory. When the drill had reached a depth of about 460 feet, gas was found which is reported to have escaped with sufficient violence to throw dirt fifty feet into the air. The drillers had some difficulty with it in the way of losing a few joints of piping, which caused them to abandon it and drill a second well near by. The new one was not as good as the first, and was finally stopped up and abandoned. They then returned to well number one and fished out the casing and closed it in. In February it was measured and found to have an initial flow at the rate of a little over half a million cubic feet per day. It soon exhausted itself, however, showing that it was in a small pocket, and not a large and strong gas area.

The difficulty in estimating accurately the total value of gas produced in the state has been discussed in previous numbers of these reports. Such difficulties by no means grow less as developments multiply. Neither will any statement on the subject correctly indicate the capacity of our gas wells, for many of them are closed in and have never been used at all, while generally those in use have delivered only a small proportion of their capacity.

It is estimated that during the year 1902 the gas consumed had a cash value at the wells of $939,375, as shown in table XII.

Maps.

The public is continually calling for maps of the Kansas oil and gas fields. The Survey has hesitated to publish one, for the reason that developments are so rapid that before it can be engraved and printed it will be out of date to a certain extent, and therefore incorrect and misleading. However, as the demand is so great, it has been thought best to yield to it and issue a preliminary one. Plate I of this bulletin is such a map. It should be remembered that it is only preliminary, and therefore, to some extent, inaccurate, and that it only attempts to represent conditions and developments up to July, 1903. Oil and gas are so intimately associated that it is impossible to separate them, and therefore no attempt has been made.



MAP OF KANSAS OIL AND GAS FIELDS.

Areas in light blue approximate possible oil and gas fields. Areas in red are now productive.

TABLE XI.

PRODUCTION OF PETROLEUM IN KANSAS FOR 1886 TO 1902, INCLUSIVE.

Figures for 1889 to 1896, inclusive, are taken from the reports of the U. S. Geological Survey.

YEAR.*	Barrels.	YEAR.	Barrels.	Price per barrel.	Value.
1889......	500	1894......	40,000	48 cts.	$19,200 00
1890......	1,200	1895......	44,430	64 "	28,435 20
1891......	1,400	1896......	113,571	63 "	71,549 73
1892......	....	1897......	90,000	60 "	54,000 00
1893	18,000	1898......	†88,000	$2 00	176,000 00
		1899......	85,215	75 cts.	52,167 00
		1900......	91,294	80 "	79,035 20
		1901......	169,197	80 "	135,357 60
		1902......	322,023	90 "	289,820 70
		Totals..	1,064,830	84½ cts.	$905,565 43

* Totals include estimated value, $9820, of the product from 1889 to 1893, which was 21,100 barrels.

† Refined oil.

TABLE XII.

SHOWING VALUE OF NATURAL GAS PRODUCED IN KANSAS FROM 1889 TO 1902.

Figures for 1889 to 1896, inclusive, are taken from the reports of the U. S. Geological Survey.

YEAR.	Value.	YEAR.	Value.
1889	$15,873	1897	$155,500
1890	12,000	1898	188,840
1891	5,500	1899	257,500
1892	40,795	1900	602,596
1893	50,000	1901	768,506
1894	86,600	1902	939,375
1895	112,400		
1896	124,750	Total	$3,360,241

V.—CLAY PRODUCTS.

THE different clay industries during the year 1902 were unusually prosperous, yielding a total product larger than ever before known. The unusual demand for building brick, sidewalk brick, and street pavers, due to the general industrial developments throughout the Mississippi valley, created a market which could hardly be supplied. Kansas brick was shipped as far south as Galveston and New Orleans, north to central Nebraska, and west to Colorado. All the plants in the state were run to their full capacity, and many of them were greatly enlarged and a number of new plants were erected.

New Plants.

At Pittsburg a large sewer pipe, drain pipe and hollow brick manufactory was installed, which began operations late in 1901. It is located just outside the southwest limits of the city, and gets its shale immediately at the factory. Sewer pipe and drain tile of the ordinary kind are made. The hollow brick industry was started as an experiment. Large, hollow brick, from eight to twelve inches in diameter and from one to two feet in length are made, so that the walls are from one-half to three-fourths of an inch thick, the object being to use only so much clay as will be necessary to give the desired strength. It is probable that such brick will come into general use for walls of buildings, and that they will be more serviceable than ordinary brick, on account of the air passages in the walls keeping out all moisture.

Table XIII exhibits the amount and value of the different kinds of brick made. It will be noticed that the amount of common brick made is much greater than any other variety. The total value of the entire production aggregates a little more than a million dollars, which is well divided between the different varieties of brick, sewer pipe, drain tile, pottery, and clay burnt for railroad ballast.

TABLE XIII.

SHOWING AMOUNT, KIND AND VALUE OF KANSAS CLAY PRODUCTS FROM 1892 TO 1902, INCLUSIVE.

Figures for 1893 to 1896, inclusive, are taken from the reports of the U. S. Geological Survey.

YEAR.	Common brick.			Dry-pressed brick. *a*			Re-pressed brick.			Vitrified brick.			Other brick, value.	Drain-tile, value.	Other clay products, value.	Total value.
	No. of thousand.	Av. price per M.	Value.	No. of thousand.	Av. price per M.	Value.	No. of thousand.	Av. price per M.	Value.	No. of thousand.	Av. price per M.	Value.				
1892 *b*.....	25,000	$5 75	$142,750	550	$7 50	$4,125	....	......	....	10,600	$8 00	$84,800	....	$6,000	$5,000	$242,675
1893 *c*....	20,000	5 75	115,000	1,000	7 50	7,500	....	......	....	8,000	8 00	64,000	....	5,000	4,500	196,000
1894 *d*.....	24,518	5 75	141,042	......	......	....	....	......	....	7,948	7 21	57,310	....	8,048	12,175	218,575
1895.......	20,756	5 87	121,892	3,730	6 91	25,275	....	......	....	7,902	7 87	62,190	....	4,090	33,700	247,647
1896.......	19,694	5 59	110,254	1,541	6 13	9,440	....	......	....	16,934	7 39	125,293	......	4,400	10,700	260,087
1897.......	19,548	5 33	104,257	1,948	5 26	10,241	....	......	....	18,378	7 18	132,222	......	7,600	11,000	265,320
1898......	23,157	6 34	146,765	5,050	5 55	28,050	1,525	$6 72	$10,250	26,182	7 28	190,735	$6,088	8,592	150	390,630
1899......	25,750	6 25	160,937	6,225	6 00	37,350	3,275	7 25	25,381	26,478	7 25	181,943	......	9,275	844	415,730
1900.......	56,921	5 36	305,209	*f*	*f*	*f*	7,500	7 50	56,250	44,970	7 12	320,105	21,555	10,250	*e* 116,363	829,732
1901.	69,706	5 55	386,868	*f*	*f*	*f*	11,665	8 00	93,320	41,319	7 52	310,719	23,175	11,126	*e* 102,600	927,808
1902.......	70,210	4 69	329,281	17,000	8 59	146,030	8,293	5 41	44,865	44,941	7 29	327,619	145,000	5,560	45,000	1,063,881
Totals...	375,260	$5 50	$2,064,258	....	....	....	32,258	$7 13	$230,066	253,652	$7 32	$1,856,936	195,818	$79,941	$342,032	$5,058,085

a. Previous to 1898 all pressed brick were figured together.
b. Only a partial report is obtainable for 1892.
c. Estimated.
d. For 1894 the common and pressed brick were figured together.
e. Principally for railroad ballast.
f. No report.

VI.—GYPSUM.

NO special changes have occurred in the gypsum industry in Kansas since the publication of the report for 1901. A new mill was erected at Blue Rapids by the United States Gypsum Company, which brings the number again back to three plants in operation in that part of the state. The plant at Springvale belonging to this company has been idle a greater part of the year. At present the only plants in operation in the state are those belonging to the United States Gypsum Company, as follows: Two at Blue Rapids, one at Hope, and one at Springvale, as above mentioned, all of which use rock gypsum; two belonging to the Salina Cement-plaster Company, one at Longford, using the gypsum earth, and one at Blue Rapids, using rock gypsum, and one at Burns, using gypsum earth. In addition to these, there is a mill at Medicine Lodge which for years has declined to give any information regarding its production either in quality, quantity, or value.

Table XIV shows the amount of gypsum sold, and its manufactured products sold in Kansas from 1889 to 1902, inclusive. The production for 1902 was 51,386 tons, which had a value of $5 per ton at the factory, aggregating $256,930 for the year.

No changes of importance have been made during the year in any of the mining or milling processes. The organization of the United States Gypsum Company has had, in general, the effect of increasing the price of plaster. In table XIV it is shown that during the last fourteen years the price has fluctuated from $5.44 to as low as $3 per ton. It is probable that so long as the present organization exists prices will be much more stable.

TABLE XIV.

SHOWING AMOUNT AND VALUE OF GYPSUM PRODUCED IN KANSAS FROM 1889 TO 1902,* INCLUSIVE.

YEAR.	Output in tons (2000 pounds).	Average price per ton.	Value of output.
1889	17,332	$5 44	$94,235
1890	20,250	3 58	72,457
1891	40,217	4 01	161,322
1892	41,016	4 76	195,197
1893	43,631	4 16	181,599
1894	64,889	4 65	301,884
1895	72,947	3 74	272,531
1896	49,435	3 00	148,371
1897	50,045	5 05	252,811
1898	39,776	3 26	129,652
1899	61,103	4 30	262,743
1900	56,112	4 35	244,611
1901	49,217	4 25	209,172
1902	51,386	5 00	256,930
Totals	657,356	....	$2,783,515

*Figures from 1889 to 1896, inclusive, are taken from the reports of the United States Geological Survey.

VII.—HYDRAULIC AND PORTLAND CEMENTS.

THE only hydraulic cement factories in the state are the two at Fort Scott, reported upon from year to year ever since this series of reports began. The material used in the manufacture of hydraulic cement is an impure limestone, which is generally known as the "Fort Scott cement rock." The processes of obtaining material and manufacturing the cement have been described so frequently, with chemical analyses of the cement rock, that nothing new need be added. Table XV shows the production of this cement from 1888 to 1901, inclusive. During the past year the total production was 154,681 barrels, with an average value of fifty cents per barrel at the factory, aggregating $77,340.50. With the gradually increasing production of Portland cement so generally throughout the United States, it seems that the demand for hydraulic cement is gradually on the decline.

TABLE XV.

SHOWING AMOUNT AND VALUE OF HYDRAULIC CEMENT PRODUCED IN KANSAS FROM 1888 TO 1902, INCLUSIVE.

The figures from 1888 to 1896, inclusive, are based upon the reports given by the U. S. Geological Survey.

Year.	Barrels.	Price per barrel.	Value of output.
1888	40,000	75 cts.	$30,000 00
1889	150,000	70 "	105,000 00
1890	150,000	70 "	105,000 00
1891	140,000	69 "	97,400 00
1892 *	110,000	69 "	77,000 00
1893	60,000	35 "	21,000 00
1894	50,000	50 "	25,000 00
1895	140,000	40 "	56,000 00
1896	125,567	40 "	50,226 00
1897	160,000	40 "	64,000 00
1898	160,000	38 "	60,800 00
1899	140.000	45 "	63,000 00
1900	127,339	40 "	50,333 00
1901	131,372	43 "	56,490 00
1902	154,681	50 "	77,340 50
Totals	1,838,959	51 cts.	$968,629 50

* Includes Kansas City, Mo.

PORTLAND CEMENT.

It seems quite probable that Kansas will soon be the seat of extensive Portland cement manufacturing enterprises. Already there is one large plant at Iola which began with a good capacity, and subsequently was enlarged to 3500 barrels per day. At the present time three or four other plants are projected, and probably will be built. The large supply of natural gas which Kansas is now offering to manufacturers, the inexhaustible deposits of good material for cement making conveniently located in the gas-fields, coupled with the rapidly increasing demand for Portland cement, cannot fail to make our state one of the great cement-manufacturing centers in the near future.

From What Made.

Portland cement is made from a variety of materials. Originally it was made from a kind of marl which nature had prepared with the proper chemical composition for making a good cement, and it is still made in a similar manner in many parts of the world. But the chemist soon learned to compound cement materials so that a product of any desired composition could be made synthetically from raw materials of desired composition. This is now considered the better method, as it produces a product more nearly uniform in character than is usually made from a natural marl, the composition of which is liable to vary from place to place.

The materials most commonly used for making Portland cement synthetically are limestone and some form of clay, ordinary clay shales, such as are so frequently used in brick making, being most extensively employed. Limestones and shales may vary widely in composition, provided objectionable impurities are not present. Nature's process of making limestones resulted in most cases in mixing of impurities along with the pure calcium carbonate, so that a pure limestone is rarely found. One having 95 per cent. of calcium carbonate is fully as good as the average, the world over, while limestone which is 98 per cent. or 99 per cent. pure is quite a rarity. Fortunately the impurities most commonly present are the same in

chemical nature as clay or clay shales, and therefore their presence in the limestone is in no way detrimental. This is well illustrated by the limestone in the Lehigh valley, Portland, Colo., and some other places where so much Portland cement is made, the limestone carrying only 70 per cent. to 76 per cent. of calcium carbonate, making it necessary to add a small amount of a higher grade limestone shipped in to supply the desired amount of lime.

Chemical Composition.

A good Portland cement is composed principally of lime, silica, and alumina, with a small amount of iron almost always present, traces of magnesia, and perceptible amounts of alkalies. A comparison of results obtained by analyzing many of the best grades of cement, both domestic and foreign, warrants limitations in percentage composition, as shown in the annexed table, which has been published frequently:

	Minimum.	Maximum.
Silica (SiO_2)........................	19 per cent.	26 per cent.
Alumina (Al_2O_3)....................	4 "	10 "
Iron oxide (Fe_2O_3).................	2 "	5 "
Lime (CaO)........................	58 "	67 "
Magnesia (MgO)..................	0 "	5 "
Sulphuric acid (SO_3)..............	0 "	2.5 "
Alkalies (K_2O and Na_2O)..........	0 "	2.8 "

Different chemists who have studied the chemistry of Portland cement agree that the essential ingredients are: A tri-calcium silicate molecule, $3CaO.SiO_2$, which is accompanied by varying amounts of similar molecules of calcium and aluminum, and calcium and iron, the exact formulæ of which are not yet so well established. LeChatelier gives the composition $3CaO.Al_2O_3$, and $3CaO.Fe_2O_3$, while Newbury holds it should be $2CaO.Al_2O_3$ and $2CaO.Fe_2O_3$. The ratio between lime and silica is about 2.8 to 1; between lime and alumina, about 1.1 to 1; and between lime and iron oxide, about 0.7 to 1. It is evident, therefore, that the per cent. of lime required will vary with the amount of alumina and iron present. Should we have a cement composed entirely of the lime-silica molecule, it should have

about 73.7 per cent. lime and 26.3 per cent. silica to correspond with the above formula. But the alumina and iron oxide present cut this down materially. Should the cement be composed entirely of the lime-alumina molecule, it would have but a little over 52 per cent. of lime; but should it be composed entirely of the lime-iron molecule it would contain little more than 41 per cent. lime. It is evident, therefore, that the higher the proportion of iron and alumina the lower will be the proportion of lime and silica.

At present it is not definitely known just what effect the alumina and iron have on the cement. Evidently they lower the fusion point of the clinker, and therefore reduce the cost of burning, particularly the iron. A proper amount of them is therefore desirable. It is generally believed that the combined alumina and iron oxide should not exceed one-half the amount of silica. A desirable shale, therefore, is one which has some alumina and iron oxide in it to render the clinker easily fusible, and at the same time not enough to make the cement too quick-setting nor to reduce the proportion of the tri-calcium silicate molecule too greatly.

Certain materials existing as impurities in limestone or in fuel are to be avoided, such as magnesia and sulphur. It is generally believed that magnesia is objectionable, although the writer must confess that it looks to him a little as though this is a prejudice rather than a well founded criticism. Years ago engineers generally held that not exceeding 2 per cent. of magnesia should be present; later they raised this to 3 or 4 per cent., and now many of them admit that 5 per cent. is allowable.

Similarly, the amount of sulphur should not be very great, but just how much is variously stated by different engineers. It is probable that the particular condition in which the sulphur exists also is an important consideration. In the table quoted above the sulphuric oxide is limited to 2½ per cent. Yet, when plaster or gypsum is added to retard the setting this amount may be considerably exceeded, as the sulphuric acid thus added, being already in combination with the lime, cannot exert any considerable chemical influence on the cement

itself. During the last eighteen months the price of good coal has been so high that many cement manufacturers, it is reported, have resorted to the use of cheaper coal, which carries more sulphur. In this way, it is said, we have had forced upon us cements with the sulphur content considerably beyond the danger line as previously fixed, and this without any bad results following.

By way of summary, then, it may be stated that a good Portland cement can be made from a limestone carrying from 75 per cent. to 100 per cent calcium carbonate, by mixing it in proper proportions with clay and clay shales, provided the impurities present in the limestone are principally silica, alumina, and iron, and provided further, that neither the limestone nor shale has sufficient magnesia or sulphur to exceed the limits above stated. A limestone having from 85 per cent. to 90 per cent. calcium carbonate may be, therefore, just as desirable as one theoretically pure. The clay and clay shales may have a high proportion of lime present, as many of our Kansas shales do, and still be very desirable, for the lime in the shale will serve the same purpose as lime in the limestone. The main features to guard against are, too large an amount of magnesia or sulphur, and a combined amount of alumina and iron oxide not greater than one-half the amount of silica.

Kansas Materials.

The State Geological Survey of Kansas has devoted considerable energy during the last three years to a study of Kansas materials and conditions surrounding them. Of first importance it considers the question of chemical composition of the limestones and shales. General stratigraphic work has been carried to a sufficient degree of completeness to enable us to trace the different limestone outcroppings with a high degree of accuracy entirely across the state. It is interesting to note that each particular limestone horizon in most cases maintains a regularity in chemical composition to a remarkable degree throughout great horizontal distances. The appended analyses warrant such a statement.

Our shale beds, on the other hand, are not so uniform. Their greatest variance is in the amount of sand they carry. In fact, many of the shales have so much sand that they are largely worthless. It is not at all unusual to find a stratum which will change from carrying no sand at one place to carrying enough sand at another place near by to make its use prohibitive. It is probable that limestone suitable for making Portland cement can be found in many more places than can a good grade of shale to go along with it.

Experiments of Lathbury and Spackman.

One of the methods resorted to in this study was to send typical samples of material to reputable cement engineers and have trial tests made by actually burning the cement and testing it after it was made. Lathbury and Spackman, 1619 Filbert street, Philadelphia, were selected as engineers for this purpose. About 200 pounds of limestone and 100 pounds of shale chosen from a limestone horizon as extensively developed as any one in the state, with a desirable bed of shale near by likewise extensively developed, were selected from which to take the samples. These two materials have been traced in detail almost entirely across the east end of the state from north to south, and are known to exist in sufficient quantity to supply the whole world with all the Portland cement desired for more than a thousand years. Further, throughout a considerable portion of this development they are located convenient to large bodies of natural gas, are well supplied with good railroad facilities, and present in many places as good surface features for establishing mills as do any adjacent limestone and shale beds anywhere in the state.

The limestone, as analyzed by Lathbury and Spackman, has the following composition:

Lab. No. 1256. Limestone.

Silica (SiO_2) and insoluble matter	3.11 per cent.	
Alumina and iron oxide ($Al_2O_3 + Fe_2O_3$)	1.06 "	
Lime (CaO)	52.40 "	$=93.58$ CaCO.
Magnesia (MgO)	trace.	
Sulphuric anhydride (SO_3)	none.	
Loss on ignition	42.45 per cent.	

The shale has the following composition:

Lab. No. 1257. Shale.

Silica (SiO_2)	50.80 per cent.	
Alumina (Al_2O_3)	16.75 "	
Iron oxide (Fe_2O_3)	4.83 "	
Lime (CaO)	8.83 "	$=15.7 CaCO_3$
Magnesia (MgO)	2.19 "	
Sulphuric anhydride (SO_3)	none.	
Loss on ignition	12.24 per cent.	

These materials were mixed in the proportion of 230 parts of limestone to 100 parts of shale, the mixture ground and burnt, the resulting clinker ground to a fine powder, 2 per cent. of plaster added to retard the setting, and carried through various tests, up to and including the 28-day test. The mixture, before burning, was analyzed, with the following results:

Lab. No. 1265. Mixture.

Silica (SiO)	14.02 per cent.	
Alumina and iron oxide ($Al_2O_3+Fe_2O_3$)	6.46 "	
Lime (CaO)	42.55 "	$=75.98 CaCO$
Magnesia (MgO)	.98 "	
Loss on ignition	35.89 "	

The cement, after having the 2 per cent. plaster added, gave the following results:

Lab. No. 1269. Resulting cement.

Silica (SiO)	21.78 per cent.
Alumina and iron oxide ($Al_2O_3+Fe_2O_3$)	10.86 "
Lime (CaO)	63.17 "
Magnesia (MgO)	1.50 "
Sulphuric anhydride (SO_3)	1.54 "

Commenting upon the results of their first analytical work, Lathbury and Spackman wrote: "The analysis of the sample of limestone, No. 1256, shows it to be a good limestone and one well adapted to the manufacture of Portland cement. The analysis of the shale, No. 1257, shows a well-proportioned shale, and one that can be used successfully in conjunction with limestone No. 1256 in the manufacture of Portland cement."

Commenting on the cement made, they wrote: "The analysis of this cement shows a well-proportioned cement, and a specially good feature, its very low magnesia content."

After the cement was ground and tested the following report was received:

LABORATORIES OF LATHBURY AND SPACKMAN, INCORPORATED.
PHILADELPHIA, PENN., August 28, 1903.

Report of test of Portland cement.
Submitted by Erasmus Haworth, Lawrence, Kan.

Fineness.

Passing No. 100 sieve, 97.50 per cent.
Passing No. 200 sieve, 76.35 per cent.

Constancy of volume test.

Normal pat., test Am. Soc. Civ. Engineers.
Cold water pat., good.
Air pat., good.

Setting time.

Initial set, 20 minutes.
Final set, 55 minutes.
Water, 24 per cent.
Temperature of air, 78° F.
Temperature of water, 74° F.

Accelerated test.

Warm-water test, good.
Boiling-water test, good.

Tensile strength of standard briquettes (1 sq. in. section).

No. of briquette.	Composition.	Water.	Time.		Total.	Date made.	Date tested.	Strength.	
			In water.	In air.				Briq's.	Av.
20,580 1 2	Neat.	24%	24 hours.	....	24 hours.	May 26	May 27	225 250 240	238
20,590 1 2	Neat.	24%	24 hours.	6 days.	7 days.	May 26	July 2	485 495 500	490
20,595 6	1 cement, 3 sand.	12%	24 hours.	6 days.	7 days.	May 26	July 2	340 320	330
20,590a 1a 2a 3a 4a	Neat.	24%	24 hours.	27 days.	28 days.	May 26	June 23	635 647 621 652 638	638
20,595a 6a 7a 8a 9a	1 cement, 3 sand.	12%	24 hours.	27 days.	28 days.	May 26	June 23	425 432 430 435 427	430

Tests of Different Cements.

In order to compare the above tests with those made on other cements, the following quotation is made from "The Mineral Industry," vol. VI, p. 115:

The tensile strength of American cements in ordinary tests is given by table

below. They represent tests of random lots of cement, without any selection for the purpose, and may not always be fairly representative of the products. Standard European results are added for comparison. The sand mixtures are in all cases one to three:

BRAND.	Seven days.		Twenty-eight days.		One year.	
	Neat.	Sand.	Neat.	Sand.	Neat.	Sand.
	lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
Saylor's	615	190	816	263	830	......
Giant	441	213	605	251	672	342
Jordan Giant	590	170	734	233	607	341
Alpha	464	181	773	413	807	......
Empire	476	......	642	......	903	380
Sandusky	542	202	879	302	860	414
Diamond	460	168	660	266	727	340
Atlas	792	191	993	346	860	......
Vulcanite	885	333	860	384	......	......
Brooks, Shoobridge & Co.	577	221	632	262	902	364
Dyckerhoff	......	......	643	224	835	319
Star Stettin	515	182	692	268	873	306
Germania	......	......	575	214	733	312
Germania	......	......	......	......	655	387
Condor	681	243	765	334	833	401
Hemmoor	......	......	614	190	874	310
Hemmoor	......	242	......	......	616	444
Alsen (yellow label)	......	......	......	......	600	308
Alsen (white label)	......	......	863	302	937	364
Mannheimer	458	182	......	......	......	......
Lagerdorfer	451	151	519	232	660	342
Added—Neodesha, Kan	490–500	330–340	638–652	430–435	......	......

For the successful manufacture of Portland cement the following conditions must obtain:

1. Limestone and shale of the proper composition.
2. Convenience to good, cheap fuel.
3. Materials in great abundance, close together and conveniently situated for quarry purposes.
4. Good railroad facilities.
5. An abundance of good, cheap water.
6. Suitable surface conditions for plant.
7. Favorable climate.

It will be seen that Kansas possesses all of these conditions to a high degree.

Chemical Analyses of Kansas Limestones.

The following list of analyses is collected from analyses made at different times and by different chemists; it is believed they are representative in character and certainly show a wide range of limestone desirable for making Portland cement:

COUNTIES.	Insoluble matter.	Oxide of iron and alumina.	Calcium carbonate.	Magnesium carbonate.	Sulphates.	Moisture.	Towns.
Jefferson......	6.98	1.04	90.01	1.66	....	......	————
Brown........	11.83	5.53	81.91	1.56	.05	......	Horton.
Douglas......	3.53	1.07	94.18	1.16	....	......	Lawrence.
Elk...........	.66	2.13	93.49	3.04	.36	......	Moline.
Douglas......	2.29	1.79	95.02	.79	....	......	Lawrence.
"	8.02	2.05	88.54	1.29	....	......	"
Franklin......	8.00	1.35	90.00	.12	.02	......	Ottawa.
Anderson.....	1.18	3.09	92.71	2.64	....	......	Greeley.
Leavenworth..	12.97	3.06	78.46	1.16	2.32	......	Beattie.
Franklin......	1.18	2.38	94.77	1.07	....	......	Lane.
"	3.82	a .77	94.21	1.30	....	......	"
"	3.94	1.20	93.61	1.20	....	......	"
"	4.79	1.18	93.30	1.26	....	......	"
Anderson.....	4.30	.81	92.76	.95	.23	.43	Garnett.
"	.61	al .51	97.32	.32	.43	......	"
Leavenworth..	17.49	4.09	69.07	3.06	.37	......	Sol. Home.
" ..	5.91	2.47	89.88	1.11	.38	......	Lansing.
" ..	6.20	3.31	88.17	1.88	.28	.04	"
Allen.........	1.53	1.75	94.12	2.72	....	......	Humboldt.
"	2.75	5.91	91.02	....	.14	......	Iola.
"	2.63	1.76	94.10	1.54	....	......	"
Miami........	1.50	.95	96.50	.74	....	......	Fontana.
"	1.35	1.32	96.09	1.00	....	......	"
"	2.44	.82	95.57	.80	....	......	"
Allen.........	1.99	1.21	95.20	1.10	....	......	Humboldt.
"	3.79	1.07	93.20	1.01	.20	......	"
Bourbon......	18.75	4.47	73.95	2.26	....	......	Fort Scott.
"	18.45	10.64	65.62	4.43	....	......	"
"	11.08	3.46	81.34	3.32	....	......	"
Cherokee.....	8.00	.69	97.32	.80	....	......	Galena.

The Burlingame limestone is represented in the above list of analyses by but two samples, one taken from Horton, in Brown county, and the other from Winchester, in Jefferson county. They are rather low in lime and high in clay-like impurities; that is, in the insoluble material and oxides of iron and aluminum. But as these materials have to be present in cement-making they are not objectionable. The Burlingame limestone extends entirely across the state, and doubtless carries a much

higher proportion of lime in some places than these analyses would indicate.

The Oread limestone is represented in the above list of analyses by four samples, three of them coming from Lawrence, and one from Moline, in Elk county. They have the right composition for use in making excellent Portland cement. The Oread limestone extends almost entirely across the state, reaching from points along the Missouri river above Atchison diagonally to the southwest by way of the following counties: Leavenworth, Jefferson, Douglas, Franklin, Osage, Coffey, Woodson, Wilson, Elk, and Chautauqua. It is remarkably uniform in character over this great extent.

It so happens that the above list of analyses includes more from the Garnett limestone than any other one. This is fortunate, as this limestone has a much greater extent, and is situated convenient for use in a larger number of localities than any other one in the state. The accompanying map of southeast Kansas shows the line of outcroppings of the various limestones. It will be seen that the Garnett covers a large area from Leavenworth to the southwest by way of Kansas City, Ottawa, Garnett, etc., passing up stream along the Kansas river to Eudora, the Osage river to Ottawa, the Pottawatomie river almost to Anderson county, and the Neosho river to the western limit of Allen county. It occupies the surface in a large portion of Johnson, Miami, Franklin, Anderson, Woodson, Allen and Wilson counties, in places covering a strip from ten to twenty miles in width. Usually there are two distinct beds, separated by shale from twenty to fifty feet in thickness. In most instances the lower one of the two limestones is the heaviest, in a few places reaching more than fifty feet in thickness.

Some of the analyses quoted above were made years ago, before much stratigraphic work was done, and the exact localites from which the samples were gathered is not known, neither can it be told whether they were from the upper or lower Garnett. It may be safely stated, however, that either limestone is excellent for Portland cement, as the impurities never contain much magnesia or sulphur.

The Iola limestone is known to be a good cement rock, as it is the one from which the plant at Iola obtains its supply. In chemical nature it differs immaterially from the Garnett and Oread. It extends from the east side of the state, in Johnson county, to the southwest part across Miami, Linn and Allen counties.

The Erie limestones, which lie below the Iola, cover a large portion of Linn, Bourbon, Allen, Labette and Montgomery counties. They are not represented in the above list of analyses, but it is known to the writer that they are suitable for the manufacture of a high grade of Portland cement when properly mixed with a good shale, which can readily be found in many places near the limestone.

The lower Fort Scott limestone, according to the analyses given, carries a perceptible amount of magnesium carbonate, and should be combined with a shale carrying but a small amount; otherwise the danger of excessive magnesia content would be passed. The upper Fort Scott limestone is not represented in the analyses, and it may prove to be practically free from magnesia, in which case it would probably be a very desirable limestone.

Shale.

But few complete analyses of Kansas shales have been made. Those available are given in the list following.

It is unfortunate that we have so few, as the chemical nature of the shales is no less important in this consideration than that of the limestones.

The great point to bear in mind in examining shales is the presence of too great an amount of sand, magnesia and iron. The sand and iron can be observed, and hence chemical analysis is not necessary to show their presence. The combined oxides of aluminum and iron should not exceed one-half the amount of silica. Of course chemical analysis is required to investigate these properties.

Location.	Silica, SiO_2.	Alumina and iron oxide, $Al_2O_3 + Fe_2O_3$.	Lime, CaO.	Magnesia, MgO.	Alkalies, $Na_2O + K_2O$.	Water, H_2O.
Iola	55.002	24.367	0.77	3.30	2.106	7.709
Neodesha	61.80	22.7	8.20	0.216	trace.	7.50
Coffeyville	64.62	21.82	2.50	0.43	4.15	5.01
Near Iola	57.20	26.80	5.40	3.10	3.90	7.00
Wilson county	50.80	21.58	8.87	2.19	....	5.37

VIII.—BUILDING STONE.

THE building stone industry in Kansas is not progressing as rapidly as are most other kinds of mining, yet the total amount of stone quarried is sufficient to make a fair showing. The more expensive buildings of the state are constructed principally of stone. The decrease in production is confined largely to flagging stone for sidewalks, which is largely replaced by Portland cement walks, and dimension stone for building culverts and abutments for bridges, which is largely replaced by a Portland cement concrete. Another substitution for stone quite extensively used is burnt gumbo, or clay, which is so largely used for railroad ballast, instead of broken stone, especially by the Union Pacific railroad.

Locally, in almost every city, town, and village, an ever varying amount of stone is used for the basements or foundations of buildings. It is almost impossible to get a correct report from such quarries, as little attempt is made by the quarry owners to keep data regarding the total output. The dimension stone still comes almost entirely from the Cottonwood limestone horizon, which reaches almost entirely across the state, and supplies quarries at Beattie, Frankfort, Manhattan, Alma, Eskridge, Strong City, Cottonwood Falls, and other places.

A good stone is quarried at Dunlap, the geologic identification of which has not yet been completed. Recently a promising stone has been placed on the market in a limited way from Lecompton. This rock lies a little above the Oread limestone, and for years has been quarried north of the river, in Jefferson county, and teamed to Lawrence and other points and used for curbing stone, although recently its value has been recognized sufficiently to give it prominence in structures. It was used for trimmings in the Fowler shops and the Chemistry building, at

the University, and stone from the new quarry at Lecompton is used for the basement of the new court house now in process of construction at Lawrence.

Table XVI shows estimated value of the total output for the state during the year 1902, which is given at $536,165.

TABLE XVI.

SHOWING VALUE OF BUILDING STONE PRODUCED IN KANSAS FROM 1888 TO 1902.

Figures for 1880 to 1896, inclusive, are taken from the reports of the United States Geological Survey.

YEAR.	Sandstone.	Limestone.	Grand totals.
1880	$11,000	$131,570	$142,570
1888*	1,000	144,000	145,570
1889	149,289	478,822	628,111
1890	149,289	478,822	628,111
1891	80,000	300,000	380,000
1892	70,000	310,000	380,000
1893	24,761	175,173	199,934
1894	30,265	241,039	271,304
1895	93.394	316,688	410,082
1896	18,804	158,112	176,916
1897	23,180	173,000	196,180
1898	25,000	180,000	205,000
1899	23,500	550,000	573,500
1900	31,750	455,866	487,616
1901	33,275	495,872	529,157
1902	30,290	505,875	536,165
Totals	$794,797	$5,094,839	$5,890,216

* Reports for 1888 include only (for sandstone) the production from Ritchie; and (for lime stone) the production from Winfield, Florence, Augusta, and Oketo.

IX.—SALT IN KANSAS.

AT present there are ten companies manufacturing and marketing salt in the state, seven of which produce evaporated salt, and three rock salt.

Manufacturers of Evaporated Salt.

Hutchinson-Kansas Salt Company, Hutchinson, Kan.
Carey Salt Company, Hutchinson, Kan.
Barton Salt Company, Hutchinson, Kan.
Union Ice and Salt Company, Hutchinson, Kan.
Hutchinson Pure Salt Company, Hutchinson, Kan.
Anthony Salt Company, Anthony, Kan.
Sterling Salt Company, Sterling, Kan.

Producers of Rock Salt.

Royal Salt Company, Kanopolis, Kan.
Bevis Rock Salt Company, Lyons, Kan.
Kingman Salt and Mining Company, Kingman, Kan.

Three different kinds of kettles or pans are used by the manufacturers of evaporated salt: First, a large pan with iron bottom, heated with steam pipes placed near the upper surface of the brine; second, large pans with iron bottoms, heated from below, the flame coming in direct contact with the bottom; third, pans similar to the first, but made throughout of Portland cement, with steam pipes placed near the top of the brine. The Hutchinson Pure Salt Company uses pan number two, and the Carey Salt Company pan number three. All the others have the first kind, and have practically the same pan, with slight variations in detail of construction and mechanical appliances for raking out the salt. All seven of these companies obtain the salt by having a doubly cased well reaching down to the beds of rock salt, the casing so arranged that water is pumped down the

outer tube and the brine thereby forced up through the inner tube.

The rock salt mine at Lyons has been in continuous operation for about ten years. The mine at Kanopolis has been operated somewhat irregularly about the same period. A mine was opened at Kingman about ten years ago, but was soon abandoned and a part of the machinery sold and removed. About eighteen months ago the Kingman Salt Mining Company was organized, the mine put in good shape, since which time it has been steadily in operation. A new salt company is organized at Ellsworth, four miles west of Kanopolis, under the name of Ellsworth Salt Company. They contemplate drilling wells to the salt beds and manufacturing evaporated salt, and think they will begin marketing the product about April 1, 1903.

The year 1902 was a fairly prosperous year for Kansas salt-makers. There was produced a total of 1,989,356 barrels, with an average value of 45 cents a barrel, aggregating $895,210.20, as shown in table XVII.

TABLE XVII.

SHOWING AMOUNT AND VALUE OF KANSAS SALT PRODUCTION FROM 1898 TO 1902, INCLUSIVE.

Statistics for 1888 to 1902, inclusive, from United States Geological Survey reports.

YEAR.	Barrels.	Average price.	Value.
1888	155,000	$1.219	$189,000 00
1889	450,000	.45	202,500 00
1890	882,666	.45	397,199 00
1891	855,536	.357	304,775 00
1892	1,480,100	.523	773,989 00
1893	1,277,180	.369	471,543 00
1894	1,382,409	.383	529,392 00
1895	1,341,617	.36	483,701 00
1896	1,347,793	.31	519,475 00
1897	1,224,980	.34	417,626 94
1898	1,810,809	.27	489,454 23
1899*	2,172,000	.35	760,200 00
1900	1,679,956	.65	1,091,971 40
1901	1,271,015	.60	762,609 00
1902	1,989,356	.45	895,210 20
Totals	19,320,417	....	$8,288,645 77

*Cooperage in 1899 is reported at about twenty-six cents a barrel, and in other years at proportional rates, which should be added to above totals to give a correct idea of the magnitude of the salt industry.

The Kansas River Flood of 1903.

THE KANSAS RIVER FLOOD OF 1903.

THE unusually heavy precipitation during the month of May, and the resulting extraordinary flood of the Kansas river and its tributaries the last of May and the first few days of June, 1903, were so extraordinary that it was deemed advisable to make a special examination of the results of the flood and add a description as a sort of appendix to the Annual Report on Mineral Resources for 1902. Accordingly, a number of assistants, Messrs. C. W. Cramer, C. F. Brook, E. C. Chaney, I. V. Iles, G. L. Metcalf, and F. R. Feitshans, were given the task of making a minute examination of all the river valley lying between Junction City and Kansas City, with instructions to note carefully all changes of river channel, all washings, all scourings of land areas, all deposits of sand and silt, and whatever other observations of interest might come under their notice. Each man traveled alone, and was assigned a certain special area, so that in a few weeks' time the entire distance between the two points named was covered. The following report, with maps and illustrations, it is believed, will fairly set forth the conditions and permanent changes brought about by the flood.

It is not intended in any way to give an account of the disasters resulting in great loss of life and property, or what may be called the human side of the story of the flood. This sad task will be left to others. It is understood that the State Historical Society is taking active measures in this direction. The report is devoted rather to the geologic side of the subject.

Not since the settlement of the Kansas river valley had such a flood been known. It seems probable that during 1844 the waters were equally high, or possibly higher. But our knowledge of this flood is so meager and so few people had it in mind

that the citizens in general were satisfied in the belief that they were dwelling in safety. This confidence that the river never would reach a height beyond that known on previous occasions since 1860 is almost entirely the cause of so great a destruction of life, and to a great extent the destruction of property as well. It seems almost incredible that intelligent citizens would persist in remaining in their homes until they were swept away by the water when the rise of the river was so gradual. But when we remember that every one had this idea of safety based upon all experience since the country became inhabited by white man, it need not seem so strange. The river rose gradually, giving ample time for all to escape with their lives and movable property. As it came up inch by inch, every one kept thinking that certainly it was at its highest stage, and therefore considered himself in safety. When the highest point known to man was finally reached, and then another foot, and another, and another, until the water spread from bluff to bluff throughout almost the whole distance from Junction City to Kansas City, occupants of the valley found to their terror that previous floods furnished no criteria.

In many cases loss of life resulted from the breaking of a small levee, such as a railroad grade across an old channel or an embankment of some kind thrown up for one cause or another, permitting an onrush of water unusually great. In other instances, parties left their homes, and, in endeavoring to reach dry land, met with one form of accident or another, resulting in death. Still again, some rescuing parties gave up their lives while trying to save others.

Character of Rivers.

Rivers are agents which help to write geologic history. They have a beginning, a life period, and an ending. During their life they perform certain work and accomplish certain results. When undisturbed by earth movements or other extraordinary influences all rivers pass through practically the same stages and act essentially in the same manner. Variations of conditions, of course, bring great diversities in results.

A river cuts its channel to a depth beyond which it cannot go. During this period the deepening of the channel is the most noticeable result, as the ratio of deepening to widening is so marked. When a stage is reached beyond which deepening of channel is no longer possible, the next most noticeable phenomenon is the widening of the river valley by the recession of the bluff lines. Natural processes of rock disintegration compel the bluff lines to recede farther and farther from their original positions until they coalesce with similar bluff lines of other streams. At times of high water the river overflows its banks, depositing vast quantities of silt, which has a tendency to build up all the valley lands, as flood succeeds flood. The area thus built up is known as the river flood-plain.

Rivers meander from bluff to bluff throughout the whole course of their flood-plains. In this respect all streams are alike, no matter whether it be the little rivulet carrying rainfall from a forty acre farm or the great Father of Waters, thousands of miles in length. One may observe this peculiar and interesting meandering by observing any stream in Kansas, no matter how big or how little it may be. Such meanderings of the Kansas river and conditions depending thereon were the most important factors of destruction during the flood of 1903.

Straightening of River Channels.

Had the laws of nature been such that streams normally produce and maintain straight channels, or had some great work of man straightened the course of the Kansas river previous to this flood, we may well believe the destruction of life and property, of fields and farms, would not have been half what it actually was; for an examination has shown that more than ninety per cent. of the damage done to farm lands was directly connected with sharp curves in the river channel.

So far as known to the writer, this is a subject never considered seriously by engineers. For years we have had a law for the assessment of taxes on adjacent lands for the purpose of building levees along some of our streams to prevent an overflow of the valley lands, and a great deal of work of this kind

has been done. During the extraordinary session of the state legislature which met June 24, 1903, a bill was introduced in the senate providing for an appropriation to cover expenses for a preliminary survey of the Neosho river, to determine approximately the cost of straightening its channel. In support of the measure it was claimed that if the channel could be straightened its length would be materially shortened, and the velocity of the water thereby so increased and the run-off so accelerated that floods would be materially reduced. The measure was lost in the house, so that no investigation will be made, at least for the present.

It occurs to the writer that possibly there may be greater wisdom in this idea of straightening river channels than has generally been considered. As population increases in our fertile valleys and wealth greatly accumulates, this question may be given more attention, for protection against flood devastation gradually will become more important. Ultimately our engineers may give it serious attention, and determine whether or not it is feasible to go to the expense of compelling rivers to occupy straight channels. For, when once straightened, the expense is by no means ended. If rivers naturally meander from bluff to bluff in their flood-plains, there must be some great law producing and controlling such meanderings. Fortunately, geologists have studied rivers, and have determined to a great extent such laws, so that to-day, in any standard text-book on physical geography or geology, the outlines of such laws and such processes are given in so elementary a manner that any-one may understand them.

A long, straight channel could remain straight only under one of two conditions. If the materials composing the two banks were entirely homogeneous, so that resistance to the cutting power of the water were absolutely uniform on both sides throughout the entire life of the river, then the channel might remain straight. Or, if artificial means were resorted to which were sufficiently powerful to prevent the current from cutting either bank, likewise the channel would remain straight. It is a question of engineering but little studied how best to accom-

plish this second condition. Possibly the building of cheap but substantial jetties, similar to those so frequently found along the Kansas river between a railroad track and the water, might accomplish the purpose. But no river can have a channel either natural or artificial with the two banks entirely homogeneous. Here will be greater resistance to erosion than there, caused by a firmer bed of clay, a buried log or snag, or some other object, great or trivial, which will deflect the channel against a soft place in the opposite bank. When once begun, the constant striking of the current against the bank will as constantly wear it away, for flood-plains, being of an alluvial nature, are easily corraded. Soon there is a pronounced curve in the channel which is ever intensified, because water flows the swiftest on the convex side of the curve, where it must travel the fastest in order to accomplish its journey. Its excessive velocity makes it possible to corrade a bank more and more, while the decreased velocity on the concave side at the same time causes a building up of a sand-bar or mud-bar, which follows with equal pace the wearing into the bank on the convex side.

The angle of curvature of a stream is dependent upon the size of the stream. In little rivulets and rills these ox-bow-like curves may be no more than twenty or thirty feet apart, while in great rivers like the Missouri and the Mississippi they are miles. Neither is there perfect regularity in their frequency. A detailed map of any stream will show that there is the greatest variation in this respect. Streams at average stages, and when slightly flushed, are constantly increasing the intensity of such curves. But when the great floods come, and the waters flow over the banks and cover the whole valley, then the principal current follows a straighter course, often cutting new channels across the narrow necks of land, leaving the old curved channel in the form of a lake or bayou. Waters at moderate stages and mild floods, therefore, produce crooked channels, but great floods tend to straighten them.

One of the most remarkable features of the recent flood in the

Kansas river valley is the pronounced tendency to straighten the course by forming new channels across the openings of the old curves. A study of the accompaning maps shows at a glance that here is where the great sand masses accumulated, implying swift currents of water; or where the most cutting or gorging and channeling of farm lands was accomplished, implying swifter currents; or, still farther, where all the new channels were formed, implying the greatest velocities. Throughout the whole distance studied there is not a single instance of a new channel being formed on the convex side of a curve. Every one so produced is on the concave side, and has resulted in shortening the length of the stream and straightening its course to some extent. Still further, every instance in which severe cutting was done, but too mild to change permanently the river channel, likewise was on the concave side of a curve, so that had the cutting been greater it would have shortened the river by straightening the channel. With such observations as these, one cannot help asking whether or not it would not be the part of wisdom to bring artificial means to help straighten the river, as contemplated in the senate bill referred to. Certainly the changes produced in the Kansas river valley by the recent flood constitute a great object lesson.

Precipitation.

The rainfall during the spring and early summer of 1903 was unusually great and unusually distributed. During April there was nothing particularly striking about it. For the week ending April 11, the heaviest rains were in the extreme southeast corner; for the week ending April 18, the heavy rains were along a narrow strip just south of the Kansas river throughout the east half of the state, with quite a small area of equal precipitation in the southeast corner, and a still smaller area on the extreme head waters of the Smoky Hill river, near the western line. During the week ending April 25, no heavy rains fell anywhere in the state. With the beginning of May, however, precipitation greatly increased. For the week ending May 2, the heaviest rain fell over an irregularly shaped area

in the west half of the state, supplying a large quantity of water to the Kansas and Arkansas rivers. During the week ending May 9, the rainfall was particularly uniform, with here and there small areas with almost no precipitation. For the week ending May 16, the precipitation was again very irregular. A small area of heavy rain along the south line of the state reached northward, covering the drainage area of the Verdigris river. Another like area is found in the extreme north part of the state, bordering Nebraska, and covering a considerable part of the Republican drainage area, with good rains throughout all the eastern half of Kansas. For the week ending May 23, the heaviest rains were again irregularly distributed over the state, occupying 15,000 to 16,000 square miles along the southern border, reaching from the east side of the state westward to the middle, and a very irregular area extending southward from the north line. The rains this week, in conjunction with the heavy rains of the past week, gave the floods of the Verdigris and Republican rivers. During the week ending May 30, immense rains covered about one-third of the state, occupying an area extending from the Missouri river westward throughout more than one-half of the state and southward from the north line about to the Arkansas river. During the month of May, and separately for each week in May, there was a much smaller precipitation at Kansas City and westward to Topeka than there was farther west.

Summarizing the above, we find that for the month of April the maximum rainfall at any one point was: Lakin, with 5.51 inches; Garden City, 5.10; Pleasanton, 4.83; Farnsworth, 4.51; Leoti, 4.25; Russell, 4.24; Newton, 4.15; and Delphos, 4.02. The reports of the United States signal office at Topeka, from which the above was taken, included nearly one hundred observation stations. From twenty-nine of these the rainfall varied between three and four inches, and for all the remainder less than three. For May, however, there was a great increase. Salina had 17.34 inches; Republic, 17.13; Frankfort, 16.34; Columbus, 14.47; Grenola, 14.33; Hanover, 14.25; Harrison, 13.70; Clay Center, 13.36; Horton, 13.32; Pittsburg, 13.20;

Concordia, 13.15; Wamego, 13.11; Holton, 13.09; Atchison, 12.48; Oswego, 12.04, etc., with an unusually heavy rainfall for almost all the remainder of the state. It will be noticed that the heaviest rainfall was within the drainage area of the Kansas river. The 17.34 inches at Salina, the 17.13 at Republic, the 16.34 at Frankfort, and a large part of the 15-, 14- and 13-inch localities are in the same area. The time of the heaviest precipitation was near the end of the month, with a fall of 5.25 inches at Salina in twenty-four hours. The unusually heavy precipitation earlier in the month had already completely saturated the ground and had raised the streams to unusual proportions before the last week of the month. Following such a set of conditions, the abnormal rainfall during the last week caused the remarkable flood.

Effects on River Flood Plain.

The general effects of the flood upon the river valley or flood plain were enormously great. The amount of material deposited would probably equal a film four to six inches deep all over the entire valley. In some places it reached a thickness of five or six feet; frequently over a forty-acre field of alfalfa it would be from two to four feet, and very general; in fact, all over almost all the remaining parts of the valley it has a thickness of from two to six inches. The accompanying maps (plates I to IV) are presented to illustrate the present channel of the river, the new channels produced by the flood, the areas badly washed, the areas covered by sand, and the areas covered by silt or soil.

Let us begin at Junction City and follow the stream downwards to Kansas City. The legend of the map is as follows: V-shaped stippling for mud and silt deposits, small circles for sand deposits, and small plus signs for areas badly washed. It will be noticed that on the east side of the Saline river near its mouth is quite an area covered by sand. Here the water of the Saline, meeting the sharp curve, jumped out of its banks on the east side and flowed with such rapidity that it carried away fine silt and left the coarser sand behind. This condition reaches down stream irregularly to beyond Fort Riley, with but little

sand on the north side of the Kansas river from Fort Riley throughout a distance of four or five miles. Here and there are small areas, generally just below a sharp curve, where the river channel impinged against the bank, and finally, with sufficient rise, jumped out of it. On the south bank of the Kansas river conditions are very much the same. A large amount of sand may be found along the concave side of the big curve at the mouth of the Saline, again along the curve opposite the mouth of One Mile creek below Fort Riley, and in a number of places between here and Manhattan. It is interesting to note that invariably such sand deposits are on the concave side of sharp curves. On the north side of the river near Manhattan Beach, about five miles west of Manhattan, the valley is badly corraded, as shown on the map. Here the river was flowing nearly north, but turned abruptly to the east, so that the strong current of the stream struck against the bank almost at right angles, and finally, with the rise of the river, plunged across the land and entered the stream again two miles below.

About four miles above Manhattan, where the river makes the great turn to the south, a new channel is cut for a distance of two miles, leaving an island aggregating from 900 to 1,000 acres. This new channel, a little less than two miles in length, takes the place of the old one about four miles around. Just below the mouth of this new channel a second one is cut, as shown on the map. Here a channel a mile in length takes the place of one almost three, leaving an island of excellent land aggregating 400 to 500 acres.

Plates VII and VIII are from photographs showing the new channels; they were taken by Doctor Orr, of Manhattan, and are fully explained on the plates.

At Manhattan a large area was entirely covered by water, resulting in the filling in of the narrow neck of land in the curve of the river south of the city. Over a part of this area sand was deposited to a damaging extent, while elsewhere on the same area the soil was greatly benefited by the heavy accumulation of silt. North of the Kansas river and east of the Blue, portions of the valley were injured by cutting and by the accu-

mulation of sand. The soil over a large part of the area was greatly benefited by the flood. South of the Kansas river just below Manhattan heavy washing was done, cutting up the fields badly and piling sand in many places, so that much damage was done. Just west of St. George, on the north side of the river, the Union Pacific track was washed out and the land between the track and the river principally covered by sand. Also, about one-half way between Manhattan and St. George, at the place where the river makes the large sharp bend south, the land on the south and concave side of the river was badly washed and much sand deposited.

Wamego rests on a sort of "second bottom," a few feet higher than the river valley proper. The water did not cover this higher ground, and therefore the town was entirely uninjured. But the valley land south of the river along the concave side of the bold curve was greatly affected. On a farm belonging to Mr. Willard, a deep channel was cut which unearthed buffalo bones and bones of other animals that doubtless had roamed the valley ages ago, and left their skeletons to be covered as the river gradually built up its flood-plain. The deep cutting here came near forming a new channel about two miles south of Wamego connecting the two sides of the great bend of the river. Here and there sharp cuttings were made, completely ruining portions of farms, and large piles of sand were left elsewhere, apparently in irregular order. Over the remainder of the valley lying in this curve immense quantities of mud accumulated, leaving the soil in such places much more fertile than it was before the flood.

At Vermillion creek the Union Pacific railway track was badly damaged, apparently by water from the creek itself, and therefore not represented on the map. Half a mile south of the creek a large curve occurs in the river channel. For more than a mile above the curve the current is straight southeast, and the markings on the map show how nearly it came to forming a new channel, connecting with the river at the mouth of Wells creek, two miles below. Had such a channel been produced

about two miles in length it would have shortened the course of the river very materially.

St. Marys, like Wamego and Belvue, rests on high ground, so that it was not injured. Just south of the city is a broad, bold curve from four to five miles across. Here a most interesting result was produced. A new channel two and a half miles in length connects with a sharp bend in the old channel. A second new channel a little less than a mile in length immediately south of St. Marys cuts across the second ox-bow curve. Water at the present time, as a result, flows through the first new channel mentioned, enters the old channel at the most western point of the ox-bow curve, flows through this old channel a distance of two miles, but in the opposite direction of the old current, then through the second new channel and into the old river. This is a most interesting case, and the only one of its kind ever observed by the writer. Citizens in the vicinity say that the water is now flowing up-hill, because it is flowing in the old channel for a distance, but in a direction opposite to the former course. Here again considerable washings or cuttings occur along the left bank, where the current strikes the bank at almost right angles, and was enabled to flow across the bank with great force as soon as the water was high enough.

Below St. Marys another new channel was formed cutting across a bold ox-bow curve, so that a mile of new channel takes the place of about three miles of the old. Still farther down, southeast of Kingsville, a heavy cutting of the river almost produced a new channel between two or three miles in length. A peculiar peninsula, almost an island, is found in the river at the upper end. The water broke across the bank and flowed almost straight east two miles, and then southeast into the river, leaving destroyed farms as a mark of its destructive power. Just south of Silver Lake is another area where the river did a great deal of destruction. At the bold curve the current struck against the east bank of the river at right angles and wore away from 125 to 150 acres of good valley land by a process which resulted simply in the widening of its channel. Here a farm house was standing on an eighty-acre farm. The river not only

washed the house away, but carried away fully seventy acres out of the eighty, leaving a narrow strip of land along the eastern bank, which has not yet ceased caving, implying sooner or later much more will be carried away.

From Silver Lake down stream to Topeka there is nothing of special interest which is not shown on the map. Here and there great destruction of farm land was produced by severe cutting or the accumulation of sand.

Topeka suffered greatly. It will be noted that above the city there is a bold curve of the river to the south. North of the Union Pacific railway track, and principally within the city limits, there is an old river channel reaching across from some distance above the corporation line to a mile or two below, or to near the mouth of Soldier creek. This river channel was not very deep, and within the city the banks had become worn down until one would scarcely notice its presence. Where the Union Pacific railway crosses it just west of the city, a grade was built up making the track level with or a little above the ground on either side, and at least five or six feet above high-water mark at the mouth of Soldier creek. When the high waters finally came it was then found that the old river channel was seven or eight feet lower than the ground to the south, making the depth of water here about fifteen feet, while at the Union Pacific depot it was only seven or eight.

There is a slight conflict in statements made by the newspapers regarding the process of destruction in the old river channel. Some say that backwater from Soldier creek covered the ground in the old channel and flooded the houses, while others say that the water came from the river above. The writer of this does not know what the facts were. But it is certain that finally a strong current of water flowed from west to east through this old channel, carrying destruction before it. The last movement of the water was in this direction, as is shown by various drifts against fences, trees, and other obstacles. It seems that the grade of the railway formed a dyke across the upper end of the old channel, which prevented water from the river passing down it as early as it otherwise would have done. It

is possible that at this time water from Soldier creek did back up into the old channel; but the time came, with the increase of the flood, when the water plunged across the railway dyke, and by back-cutting soon destroyed it. Immediately a great wall of water rushed down the old river channel. This is the torrent which washed out houses before it as though they were chaff, and which produced the terrible loss of life, because it came so rapidly that people who were still in their houses were unable to escape with safety. The course of the current was uncontrollable. It rushed along Soldier creek as though it was not there, and then across the Union Pacific railway track, a mile and a half below the depot, and finally spent itself in the bottom north of the river, on both sides of Indian creek.

Just below Topeka the river makes a bold curve to the north. Here was another opportunity. An immense amount of cutting was done in the valley along the southern or concave side of the curve, resulting in almost complete destruction of farm land which had a value a week before of $200 per acre. The curves between here and Tecumseh are very peculiar and interesting and should be studied carefully on the map. Beyond the mouth of Indian creek is another bold curve to the north, which again provided a convenient opportunity for the river to shorten its course by flowing two miles or more to the southeast. Had these two cuttings been a little more excessive, the whole appearance of the river would have been changed, and we would have had a new channel curving gently to the north throughout a distance of four or five miles, leaving the old one just below Topeka and entering it again near Tecumseh.

Tecumseh is on the south side of the river and on the convex side of a short curve. The valley on the north side is badly covered with sand, and considerable corrasion may be noticed about a mile below. Two or three miles below, and on the south side of the river, is another large sand deposit, with perceptible cutting just above it. Here we have an instance of the production of sand-beds where the river is almost straight.

North of Spencer is another stretch of fully two miles with comparatively little curve in the river, and the valley is covered

with silt. East of Spencer two miles is a bold curve to the southward with sand and corrading along the concave part of the curve on the north side. From here to Lecompton we have a broad curve to the north, so gentle that for some distance it is almost straight. But after the river became high enough to pass entirely out of its banks the current cut across on the south side and washed a number of deep holes on the south side of the Santa Fe railway. In general, the valley for the first five miles above Lecompton was greatly benefited by the heavy deposits of silt which will materially enrich the soil. Only occasionally was sand deposited, and only in a few places was the current strong enough to do any considerable amount of cutting.

The same general statement may be made for the river valley for the first three miles below Lecompton. Here and there a little cutting was done and sand deposited in considerable quantities over small areas. But near Lake View conditions were greatly changed. Beginning about a mile and a half above Lake View, and continuing entirely across the sharp curve in the river opposite Buck creek, the farms were greatly corraded and covered with sand, almost destroying the value of thousands of acres. The old river channel outlined on the map on the north side just below Perry seems to have been but little, if any, affected. Likewise, the old river channel on the south side, commonly known as the "lake," was not materially affected. This is an old ox-bow curve through which the river previously flowed, touching the bluff line. Long ago the channel straightened itself by cutting across, so that a mile of new channel took the place of three or four of the old. The present flood did likewise to the sharp curve to the north. Here a new channel half a mile in length cut across this ox-bow and thereby saved a mile and a half in distance. This new channel brought the river at right angles against the stream where it now flows almost straight south. A great deal of cutting was done, therefore, on the east side, and further down where the current veers nearly east, producing a concave curve, excessive cutting was again produced.

In the vicinity of Lawrence, in the broad valley to the north,

we have a complicated arrangement of the old river channel, as shown on the map. One of these leaves the main channel four miles above Lawrence and reenters the present channel within the city limits of North Lawrence. Another branch of the old channel leaves the river about two miles above Lawrence and enters the old channel just mentioned. The Union Pacific railroad crosses this old channel three times—two times above, or north of Lawrence, and the third time below the city limits. As the river rose the water began working into this old channel at both the openings above Lawrence. The railroad grade within the city formed a complete dam across the lower end of the old channel, and therefore produced a sort of mill-pond effect, which was maintained until the water above the dam became high enough to flow over the track. Of course this condition would be reached as soon as the water had an actual elevation equal to the grade. The fall in the river made the water on the river side of the railroad-grade some four or five feet lower than it was on the mill-pond side. The railroad employees did all they could to prevent the water breaking over the track, working night and day with bags of sand, but all in vain. Suddenly the water broke through, and having the fall above mentioned immediately began back-cutting, and in an inconceivably short time washed out the railroad track, allowing a vast quantity of water to flow across the west end of North Lawrence. It was at this time that houses began going out, one of which struck the north span of the wagon bridge, tearing it away.

The loose, sandy soil of the river flood-plain seemed to produce almost no resistance. Trees from one to two feet in diameter which had withstood all tests throughout historic times were uprooted and carried downward as though they were straws. Soon the river reached a stage which carried it entirely over the valley lands, and then in order to shorten its channel it cut through at the north end of the bridge, and soon had a gorge cut to the level of the bottom of the stream below. In this way a new channel of the river was formed which has left the mill-dam at Lawrence high and dry.

Quite an interesting observation is here made regarding the

present condition of the mill-pond. It so happened that students in the engineering department of the University made a careful survey of the mill-pond early in May, just before the flood. They found that, in general, there was almost no sediment above the dam. But when the flood receded, with the new channel north of the north end of the dam, it was found that the old mill-pond was filled with sand and silt almost to the level of the dam, which sediment served as the south bank of the new channel.

The old river channels north of Lawrence extend eastward two miles or more and gradually disappear without direct connection with the present channel. But during the highest time of the flood straight currents flowed eastward along the old channel through a part of Bismarck grove and washed away portions of the Union Pacific track. Here and there in a number of places on the north side of the river between Lawrence and Fall Leaf considerable damage was done, and again a mile or so below Fall Leaf. On the south side of the river, but little damage was done until a distance of three or four miles is reached below Lawrence. Here we have a broad valley produced by the junction of the Kansas river valley with the valley of the Wakarusa, a stream about forty miles long which enters from the southwest. At two or three places throughout this valley old river channels previously existed, one of which, just above Eudora, was corraded considerably, allowing a temporary current to enter the Wakarusa half a mile or more above its mouth. There was considerable fear at the time that this would prove to be a new channel and the permanent site of the river, but such was not the case.

Eudora is situated on the south side of the river opposite a very sharp curve in the river to the south. After the water had gotten entirely out of its banks it cut across by way of Fall Leaf, where it did considerable corrading near the town and for some distance below. Here, again, it came very near forming a new channel, which would have been about one and one-half miles in length, to replace an old one of three or more. Below Fall Leaf we have another sharp bow to the north, throwing the

concave side on the south, producing an area triangular in shape aggregating about four square miles, which area was very badly corraded. Sand in objectionable quantities covered almost the entire surface, and also a channel was produced part way across the base of the triangle, which again threatened at times to become a new channel.

Linwood is on the north side of the river, about five miles below Eudora. In this vicinity the river makes a broad, gentle bend to the northward, while the Santa Fe railroad track extends almost straight east from Eudora to Desoto. When the river broke out of its banks it cut across the base of this triangle by flowing almost straight east near the bluff lines. As the distance was so shortened its velocity was greatly increased and its power to do damage was correspondingly magnified. Near Desoto it connected with a little tributary coming in from the south. For days it was thought a new channel would here be formed and permanently occupied, but the river finally resumed its old course. When the flood was passed it was found that a new channel had been cut throughout a portion of the distance—a channel thirty feet deep in places—but not connected at either end with the river channel.

It might be stated that the writer has often observed similar channels or gorges in many different river flood-plain areas—channels that had no connection at either end with the parent river—and that he has been puzzled to know how to account for them, as they were supposed to be veritable river channels. The subject was generally dismissed by concluding that the two end openings in some way had been closed up since the channel was abandoned. But here we have a new channel or gorge, and know positively that neither end ever was connected with the parent river channel. There may have been a log, or a hedge, or something else, which produced a slight fall in the water to start the cutting, or something to produce a vortex motion, described by Morscher later in this paper. When once started a fall would be produced, and the unmanageable current with its vortex motions, did the rest.

Dr. A. J. Lee, of Desoto, took a number of photographs of

this new channel as soon as the river fell enough to permit. Plate XVI shows the upper (or western) end of the channel, with its vertical walls, and water in the distance, not yet entirely within the river banks. The observer is here looking west. Plate XVII is taken with the camera almost at the same point, but turned so the observer is looking north. Here vertical banks of the new channel are shown, with the promontories along the jagged edges reaching out into the water. Plate XVIII is another of the same, with the camera turned so that the observer is looking almost straight east. Plate XIX is from a photograph taken near the lower end of the channel, with the observer looking to the northwest. Here, it will be observed, is an island in the new channel, which shows how similar such a channel is to the river proper. By observing the map, it will be seen that the new channel is little more than a mile in length, as it is now seen since the flood entirely receded, and that it does not connect with the river at any point.

The map shows that a large part of the area included in the broad curve to the south and southeast of Linwood was damaged by the corrading and by the cutting in some places where the cuttings were not so severe as in the channel just described. Lenape is on the north side of the river, almost opposite Desoto. Plate XX is from a photograph showing the condition at Lenape about a week after the highest water of the flood. The river did considerable corrading along its north bank opposite Lenape.

Lest the reader become weary with such detailed description, he is referred to the map to observe the effects of the flood between Lenape and Argentine. The channel makes five distinct curves between these two points, first to the south and then to the north. Throughout this entire distance the valley land on the concave side is greatly affected, being corraded in places and elsewhere covered with sand. Over areas where the velocity was mild vast quantities of silt were deposited, sometimes to the extent of three or four feet.

Argentine is situated on the south side of a broad, southerly curve. The river cut across on the north side of the river where sand deposits and cuttings are frequent. On the south

side, in the vicinity of Argentine, the slow velocity of the river allowed mud to be collected, covering the surface from six to eighteen inches. Here, doubtless, the conditions were modified largely by proximity to the Missouri river. Col. C. L. McClung, assistant city engineer of Kansas City, Kan., kindly furnished a map of the river valley from the mouth of the river up-stream to beyond Argentine (see plate IV). As this map is on a larger scale than the one of the entire river valley, it can be studied to better effect.

It seems that after the flood became high enough to let the water out of the river banks it traveled almost in a straight course from the southwest part of Argentine to the mouth of the river. Large quantities of sand and silt were deposited all over Argentine and in the valley below, in some places reaching four or five feet in depth. Numerous washouts were made, trending northeast and southwest, some nearly north and south, which show the direction of the current here. In addition to all this the drift of the debris tells the same story, leaving no doubt that the water ran across the valley and filled it from bluff to bluff.

It so happened that the Kansas river was at its highest about a day before the Missouri river reached its highest point. During this time the water of the Kansas river rushed almost straight across the Missouri, as shown by Colonel McClung's map, and as is also shown even to the present time by the large amount of debris which drifted along the east bank of the Missouri river. After the flood it was a noticeable and interesting fact that this part of the Missouri river bank was strewn with debris of all kinds, while the same bank further down stream had almost none.

CORRADING ACTION OF RIVER WATER DURING HIGH FLOODS.

By L. N. MORSCHER.

The corrading power of water, depending as it does upon a few simple laws, displays varied and bewildering differences in its action. The flood of June, 1903, in the Kansas river valley furnished a vast array of destructive phenomena which may be studied with interest before the subsequent actions of rain and wind have too far obliterated the minor details.

As already noted by Professor Haworth, and illustrated on his map and by photographs, many peculiar and interesting examples were produced of apparent river channels being cut or corraded in the loose sand and soil of the river flood plain. Some of these connect at one end with the river channel, but many of them do not, but are simply holes in the ground made by a force powerful enough to excavate hundreds of thousands of cubic yards of earth. They are situated anywhere and everywhere in the flood-plain area, sometimes close to the river channel, but just as frequently from one to three miles away, and when superficially examined seem to have been located at random.

Such deep erosive action outside of regular water channels may be divided into four fairly distinct classes: First, those showing a broad area with steep banks at the upper end of the wash, with narrow and more gently sloping banks at the down-stream end (figure 1); second, those with deep and narrow channels and steep walls at the up-stream ends, the channels broadening out fan-shape, and gradually becoming shallower down-stream, until the lower ends merge almost imperceptibly into the surrounding level (figure 2); third, those with shallow, narrow channels at the upper end, but which, more or less, rapidly broaden and deepen downwards (figure 3); fourth, the class excavated with steep, perhaps overhanging banks on all sides, and with irregularly varying depth, with no sign of similarity to adjacent cuts or to conditions in the bottom of the same depressions (fig. 4). Many examples of this last class were furnished in the recent disastrous flood. Great "holes,"

as the people call them, appear indiscriminately in the flooded fields and the streets of cities and towns which felt the water's force.

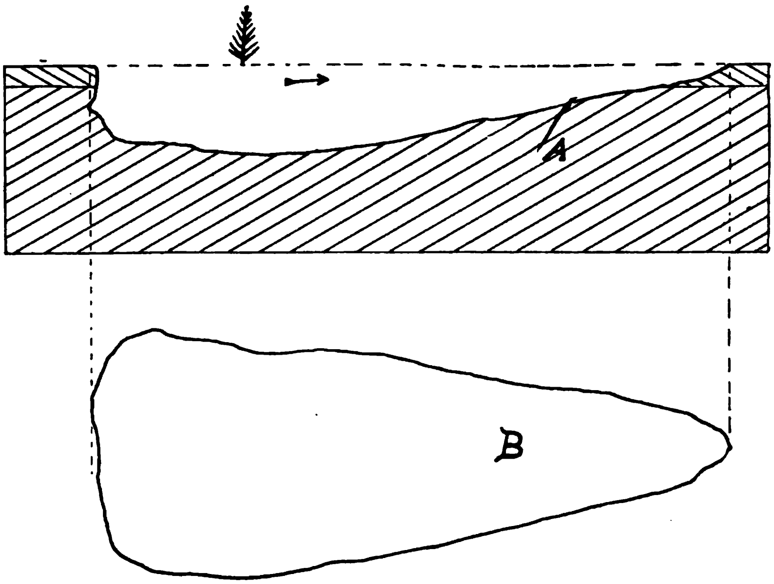


FIG. 1. Erosive type produced by an obstruction in a swift stream.

Channels of the first class can be explained, in most cases, by the presence at some time during the water's action of an obstruction which locally increased the erosive power of the water, either by setting up strong eddies, or by allowing the water to strike the surface of the ground at an increased angle and increased velocity by falling over some kind of obstruction. Along the Kansas river valley we frequently find great washouts, with no visible cause for the waters selecting that particular place to attack. People acquainted with the history of the place will tell us, however, that a hedge or some such object once stood where the depression now is. The hedge may have disappeared completely, having originally occupied the position indicated by the tree in *A*, figure 1. The hedge, to some extent, serves as a dam or dyke, producing a mild waterfall, having previously caught enough wind-blown silt to produce such

an effect; or it may hold grass, hay or other trash carried against it by the flood waters so as to act in a similar manner. The water pouring over it will first cut out the earth below, until the weakened support to the tree roots allows the hedge to be washed out. If, then, there be sufficient slope to carry off the water rapidly enough, the new channel will take a large part of the surrounding flow, which, pouring over the steep up-stream part, will constantly cut the channel back by undermining the bank at the upper end. The rapid loading of the stream with debris at the upper end of the cut will decrease its corrading power as it moves downward, until such power is almost entirely gone, and therefore the lower end of the channel will be narrow and shallow, because the water could not corrade it more. It may even deposit a part of its load close to the cut or channel upon ground of nearly the same slope as that from which the soil was removed.

If there was a long obstruction directly across the current, it may produce a broad trench at right angles to the course of the water, which is only an extreme limit of this class.

The first type of washout is most frequently produced where the surface layer is harder and more resistant than that below, as represented in *A*, figure 1. Usually large masses of coarse debris will be found at the lower end of the channel, where it was left by the weakening current force. Such material serves as a protection to the lower end of the new channel and is one cause for its growing shallower. After the water has gone down we may find small masses of this hard, top crust at the upper end of the channel, which has fallen down from the top layers as they were undermined by the water.

This first type of cut is also caused by the presence of objects about which the water rushes without being able to remove them. If such obstruction, as is often the case, causes a considerable increase in velocity of the current in places, then cutting will begin, even though elsewhere the water may be depositing sediment. This is strictly in accordance with the law of stream action, which is that the corrading force is proportional to the square of the velocity, while the load carried,

if entirely submerged, is proportional to the sixth power of the velocity. A very slight change in velocity is sufficient, therefore, to change the action of a stream from unloading sediment to cutting or corrading, and *vice versa.* This action is strongly augmented when, in passing around the object, the parts of the water meet at such relative velocities and angles that a vortex motion is set up, and especially if the vortexes are not stationary in position, as the material at the bottom then is subjected to intermittent forces applied in contrary directions, and also upward currents, which reduces the effective weight of the sand or silt, with the final result that holes are cut with almost vertical walls.

This motion of the water can easily be noticed below heavy bridge piers if they happen to restrict the flow of water just the right amount to suit their shape and size to the velocity of the currents. This was well illustrated during the high water by the effect of the piers of the Melan bridge at Topeka, as pointed out to the writer by Professor Haworth. The same may be seen in the Missouri river below the Atchison and Leavenworth bridge piers, and in many other places. The general action of the current is represented by figure 6. As the current sweeps past each side of the pier with much greater velocity than the water below the pier, it sets up rapidly moving vortexes along the contact planes separating the bodies of water of different velocity. The water level at each side of the pier usually is a little above the water surface of a wedge-shaped area immediately below. The sides tend to flow towards or into the body of water below the pier, so that they travel down stream. Now, if the velocity and height of the water be within certain limits the vortexes will travel over every portion of the space below the pier, corrading the bottom here more deeply than elswhere, if the nature of the material composing the bed of the stream permits. The higher velocity about the sides of the pier also causes a cutting of the bottom there which works back to the up-stream side of the pier, usually resulting in a deeper cut on the upper side, although frequently the conditions are such as to cause a deposit of material below. The vortexes play a far more im-

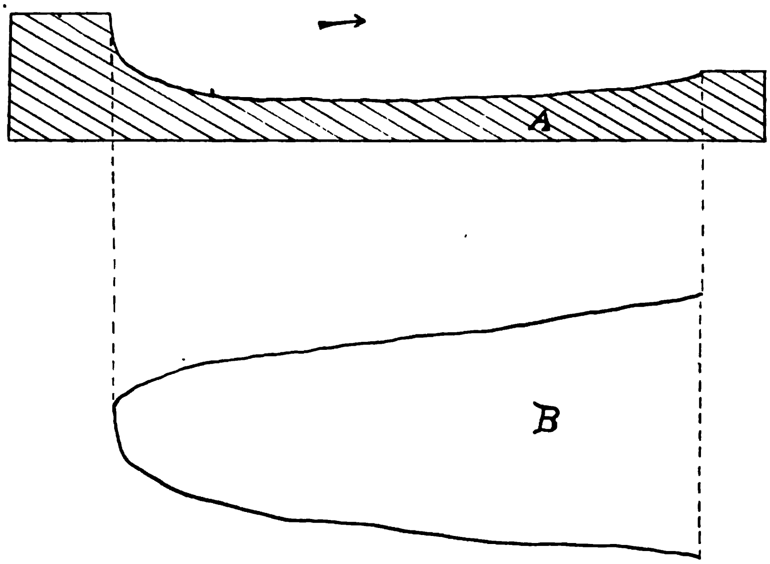


FIG. 2. Erosive type produced by a swift, shallow stream on gentle slope of loose material.

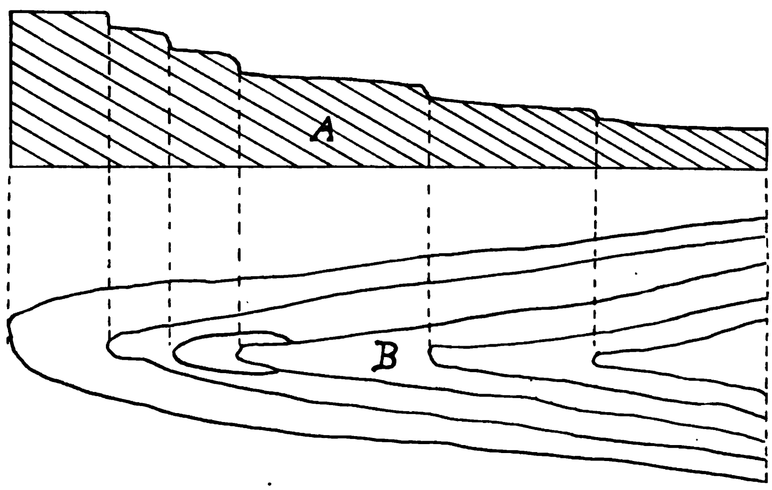


Fig. 3. Erosive type produced by a lateral tributary entering a deep channel.

portant part, however, in some other conditions to be mentioned later.

The second form of wash, figure 2, occurs when a gentle slope of fairly loose material is overflowed by a sheet of water of such velocity that it is barely able to corrade the bottom. The corraded channel is widened downwards throughout its entire length. Water from the sides comes in laterally and the cutting back of such currents widens the channel. Down-stream the cutting gradually decreases on account of the water becoming so heavily loaded with debris, as explained under the first heading.

The third form, figure 3, is produced wherever a large body of water with low velocity finds an exit over soft material forming an embankment to a lower level, and is in fact a miniature river canyon.

The fourth form, which is common with the first one, seems to be due entirely to the formation of large, stationary vortexes. A group of buildings (*B*, fig. 9) in the path of a broad, swift flood-stream, or even the meeting of two separate currents of the same stream from a distance, may cause a swift eddy which will be fairly stationary in its position and by its continued action drill out the earth beneath like a gigantic auger. Many holes were formed in the streets and town lots of North Lawrence, and were always, where seen by the writer, in such position that the direction of drift trend indicated the rapid eddying spoken of. In some places the depression would consist of several holes whose sides were more or less worn through, leaving the bottom irregular and the sides very uneven, as represented in figure 4—*A* and *B*. This shows the presence of several stationary vortexes. The drawing is a rough sketch of a hole within a few feet of the north bank of the Kansas river where it passes North Lawrence, and is where one of the returning streams, after deflection by some building, met the main stream, to be whirled back among the buildings with a rapid gyrating motion. Such an explanation, it seems probable to the writer, will account for the many deep holes formed in Kansas City. Most of them

were so related to buildings or other objects that eddies would have been formed.

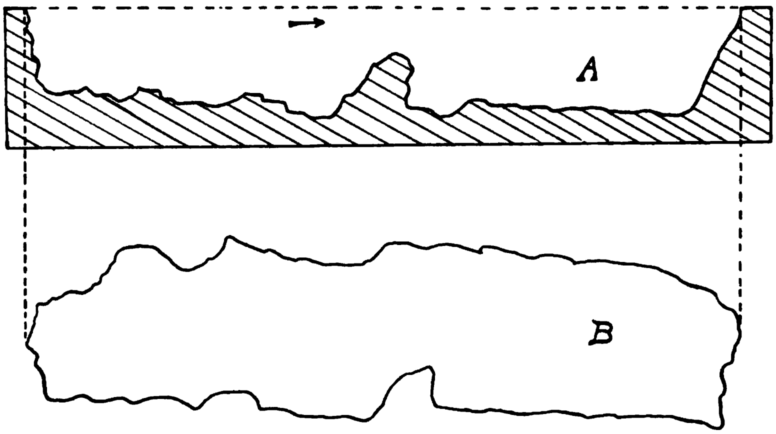


FIG. 4. Erosive type produced by vortex motion.

In some cases, a building which is struck by a broad, shallow water current has the up-stream side of the foundation washed out. The building, in leaning up-stream, will tend (fig. 5, *B*) to deflect the water down and around its base in a swift, gyratory stream, which is well adapted to undercut until, in some cases, the building seems literally to sink into the earth. Many such instances could be seen in North Lawrence and Kansas City, and probably the hole cut in the yards near the union depot, Kansas City, allowing engines and coaches to sink beneath the surface, may be explained in the same way.

This undermining action is especially marked, as is to be expected, if the water has a downward sweep from a previous obstruction before it encounters the building, so that in many cases structures which seem partly protected by more exposed buildings are undermined and destroyed first. Evidence of such effect is still to be witnessed near Bridge street, North Lawrence, where a small house, now surrounded by drifted mud deposited during the flood, stands almost directly in line with excavations below it. A large tree stands between the house and one of these holes, and is partly undermined, while the ridge of

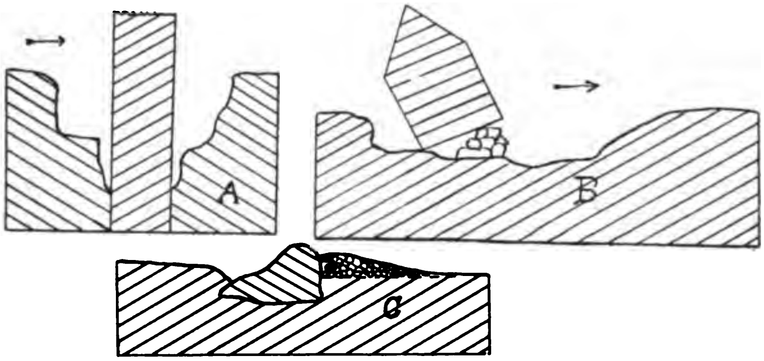


FIG. 5. Erosive types produced by different kinds of obstructions.

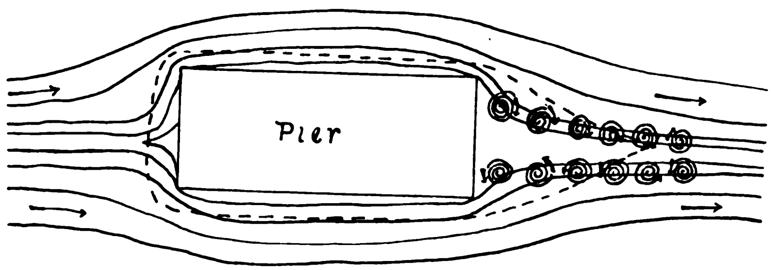


FIG. 6. Vortex action about bridge piers and other similar obstructions.

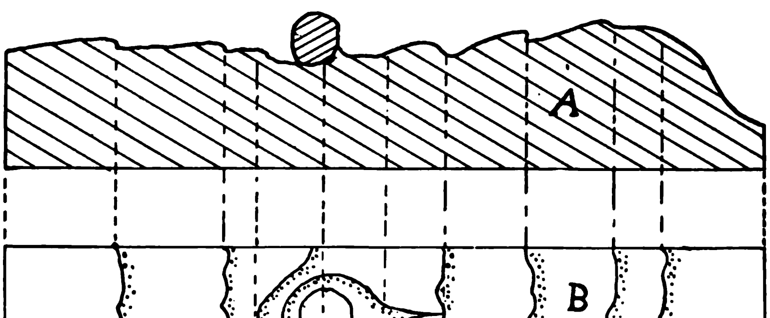


FIG. 7. Alternate corrasion and deposition as produced by drifting obstructions.

drift mud reaches to the base of the tree. After passing the first house the current had sufficient fall to prevent the eddies moving back up stream. The position of debris implies that a side current met the main one here and formed the eddies just below the tree. In some cases small houses were so surrounded by mud that considerable excavating work had to be done to get at them ; yet a few yards beyond, as in one case particularly, a large oak was completely undermined by the current, literally digging the earth from beneath its roots. Here the current was given a sudden turn near the oak by encountering an abrupt rise in the ground just beyond the tree, so that eddies or vortexes were set up.

The heightened effect of corrasion upon meeting an obstruction inclined up stream, or by letting the stream descend upon the object so that it meets it at less than a ninety-degree angle, is easily observed by an examination of telegraph poles which happen to lean up stream, or to be situated below a slight ridge (*A*, fig. 5). One of the distinctive actions of eddies upon meeting an obstruction can be better understood by referring to the able discussion given by Prof. James Thompson on the subject "River Bends." (See Proc. Roy. Soc. 1877, page 357; also Proc. Inst. of Mech. Eng., 1873, page 456.)

The strong vertical currents set up by the eddies are evidenced by many of the eddies in the Missouri, and other swift, shallow streams which are able to draw light objects down, while the upward rush of water is easily seen by the great boiling appearances so common on the surface of such streams. Moving eddies are easily seen all along the deeper side of the Missouri river near Atchison where it is brushing against the west side below the jetty protruding into the river from the coal mines, while upheavals of water are usually somewhat below and further in the stream than most of the moving eddies. The excavating effect also may be seen by the steady down-stream drifting of large trees and logs stranded upon bars over which but little water is flowing. The sand continually cleared away both above and below the log allows it to be slowly carried across a bar scarcely submerged at all.

After the last flood a very pretty example of the erosive effect of currents eddying below an obstruction was given by a water-soaked log lodged in shallow water on the north edge of the sand bar below the dam at Lawrence. The log, which was crossways to the stream, was very large at one end, and had two short snags standing vertically upwards to the surface of the water. For about two feet up stream from the log the sand was cleared away almost as deep as the log lay, while downstream for three or four feet a space was scooped out in imitation of the shadow of the log, each vertical rise on the log causing a correspondingly lengthened depression in the sand.

The action of the water currents is easily shown by the continual erosion in ripple marks moving over a drifting sand bar. Here the up stream side conforms nearly to the curve of greatest stability under the water action, while the lower edge shows both continual deposition and a renewed erosion of the upper surface of the next ripple mark below, due to the changed position of the one above. These may be further modified, as above explained, by the presence of some drifting body partly supported by the sand, as shown at *A* in figure 7.

It may be objected that every obstruction, according to the foregoing, ought to cause corrasion, while, as a matter of fact, bars are often found around piers and about jetties. This is the case where the water is loaded with sediment by some previous action and is now rapidly unloading. As it comes near some object its motion is retarded only as the increased space which allows the slowing up prevents the obstruction crowding the water into rapid motion around it. Or, again, during a flood, a stream flowing over fields with variously inclined surfaces may unload in some places of slow travel, only to be the more powerful corrasive agent in some other places, the processes being repeated by alternate drifts and washouts. This is beautifully illustrated in the Kansas river near Lawrence. Water flowing out towards the south just below Cameron's bluff reentered, in part, almost at right angles to the river at *A*, figure 9, where it deposited the dirt washed from the fields partly between the islands and the bank and partly be-

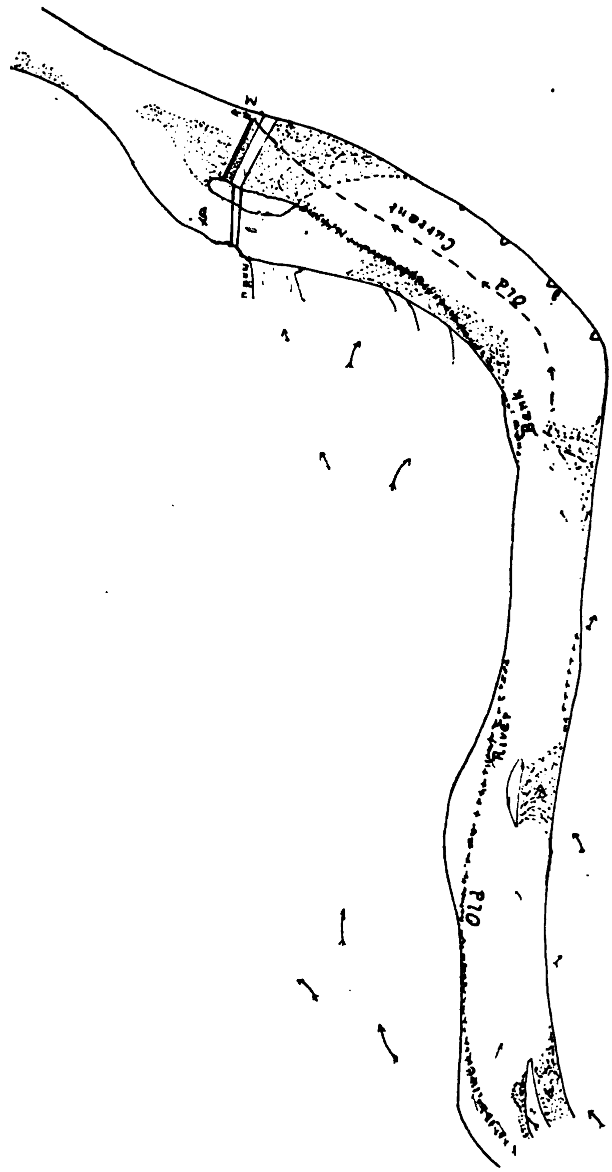


FIG. 10. Kansas river at Lawrence. Arrows indicate correct directions during the flood.

yond the islands encroaching on the north branch of the stream. This it could easily do, as at this part the south bank was the inside of a river bend, which would naturally be silted up by the swift stream, as explained by Prof. James Thompson, as above quoted, and as figure 10 will show, the swifter upper layers of a river current being carried over the lower ones towards the outside of the bend (fig. 10), only to return beneath, carrying the rolling debris with them, towards the inside of the bend, at *V*, figure 10, or *A*, figure 9. This causes a rapid cutting at every bend and a filling up at the lower part of the inside of the river bend, so enlarging the bends and tending to fill up with bars and islands the inner portions of the bends, as was shown by the filling up of the south branches of the river, at *A* and *B*, figure 9, and a corresponding cutting at opposite points, which actions are aften assisted or modified, as above mentioned, by currents outside the river banks.

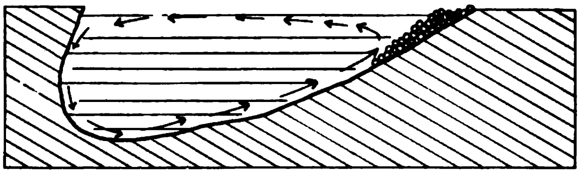


FIG. 10. Cross-section of stream at point of ox-bow curve, illustrating method of meandering.

The action explained by Professor Thompson, however, requires that the upper layers of the current be met by a restraining solid bank to return them. If, on the contrary, the stream be met by a more quiet bed of water, or a portion of the water be allowed to overflow, a large portion of the heavier sediment will be carried along with the swift overflow, or be thrown out, by its superior centrifugal action, onto the opposite bank. This action was displayed to some extent at *B* in figure 9, but much more plainly just above the dam, at *M*. Here a cross-field stream meeting the main stream formed many excavations similar to figure 4, as is still shown above the bridge on the north side. One of these eddies probably formed near the place where the water broke through around the bridge. A large one

had previously worked out a place in the north bank just below the bridge, forming for moderate heights of water a sand-collecting pond from which vast quantities of sand were taken by local consumers and by the Union Pacific railroad. The water during the flood of 1903 then piled itself up along the south bank of the river for a considerable distance above the bridge, and from thence flowed towards the old washout below the dam at the north side, making a strong cross-current.

Added to this, from the fields just north of Lawrence and west of the river flowed a strong current which, striking the low escarpment south of the Lawrence brick plant, was turned past the city water works back into the bed of the river. At this point the current had sufficient force to lift a loaded car of coal and invert the track upon which it stood. This entering current so checked the force of the stream that fine mud was deposited over the Santa Fe tracks as far down as the foot of Ohio street.

The old mill pond at Lawrence was almost entirely filled with mud and sand during the flood. As soon as the new channel was cut north of the dam this filling began, or at least it was noticeable that the current over the old mill pond was very light. Previous to this but little silt was in the pond. Only last May engineering students of the University, under Professor Marvin, had surveyed the pond and learned that no mud could be found on the bed-rock near the south side.

The channel seemed to be washed out in some such way as indicated by the broken line in figure 9, reaching from near the north bank diagonally to the gates at *M*. While the water was high enough to allow a passage for the heavy material this channel was filled up, although the gates were washed out from the mill race, and one would have expected a swift current to be maintained through this gap. The above filling process commenced near the gates, so that the river for a long time flowed far down towards the gates, only to leave the heavy material hurled out into the smaller stream and return back up its own course, past the island left at the north abutment of the bridge, and finally pass through the new channel. The filling

process thus kept up made the river take up a less and less tortuous course, until finally it cut almost straight across from the foot of Ohio street to the new cut.

In southeastern Kansas will be found many little streams lying at the bottom of narrow valleys wtih heavy limestone bluffs. Deep ponds are frequent along these creeks, and almost without exception it will be found that a large boulder, sometimes the size of a house, has rolled down into the creek and now occupies the upper portion of the pond (fig. 8). The boulders are deeply planted in the earth, and when ponds surround them one side of the boulder will always be found to be overhanging, forming fine retreats for the fish inhabitants of the pond, as every barefoot lad of the country well knows. Sometimes several such rugged boulders lie near together, and then the pond is apt to be long, with many enlarged portions bearing outlines roughly determined by the shape of the rock mass and the angle at which the current enters. Large boulders with sides sloping outward on every side towards the base frequently can be found in the stream beds, but then usualy there is only a slight enlargement in the creek channel, and that entirely above the boulder (*C*, fig. 5).

The first type of pond is shown in figure 8, where it will be seen that the overhanging side of the rock turns the stream downwards with a gyratory motion as it passes the rock. The same effect may be noticed where a bend in a stream carries it against an overhanging bluff. The water near the bluff becomes deep. The above suggests some explanation of the digging out of telegraph poles which lean up stream, as was meant to be shown in *A* of figure 5. The pole, however, by mistake is made vertical in the drawing.

The cutting away of material above an obstruction in a stream and the deposit below come in as other examples of erosive action which may be easily noticed in snowdrifts. The wind loses its momentum much more easily than water, and the particles of snow settle much more quickly than silt. Water has a similar action. One case to show the effect of this may be seen in the most dangerous form of quicksand, which seems to be due

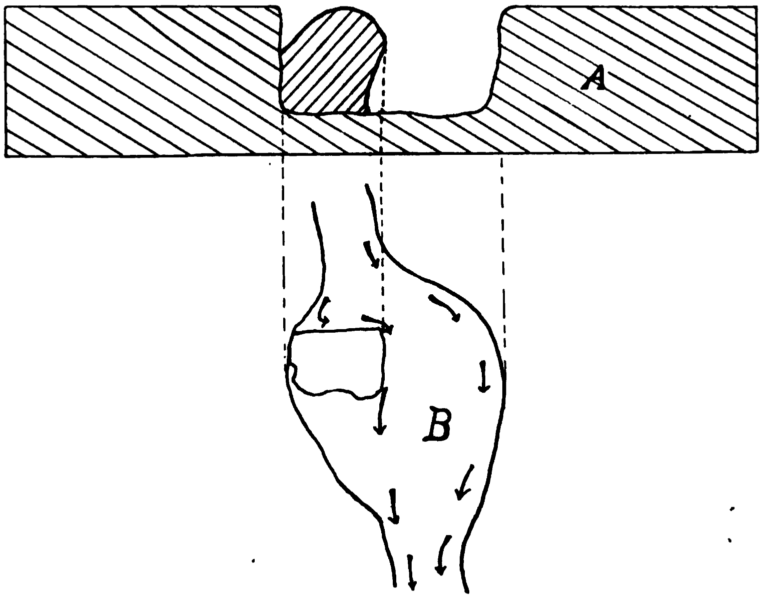


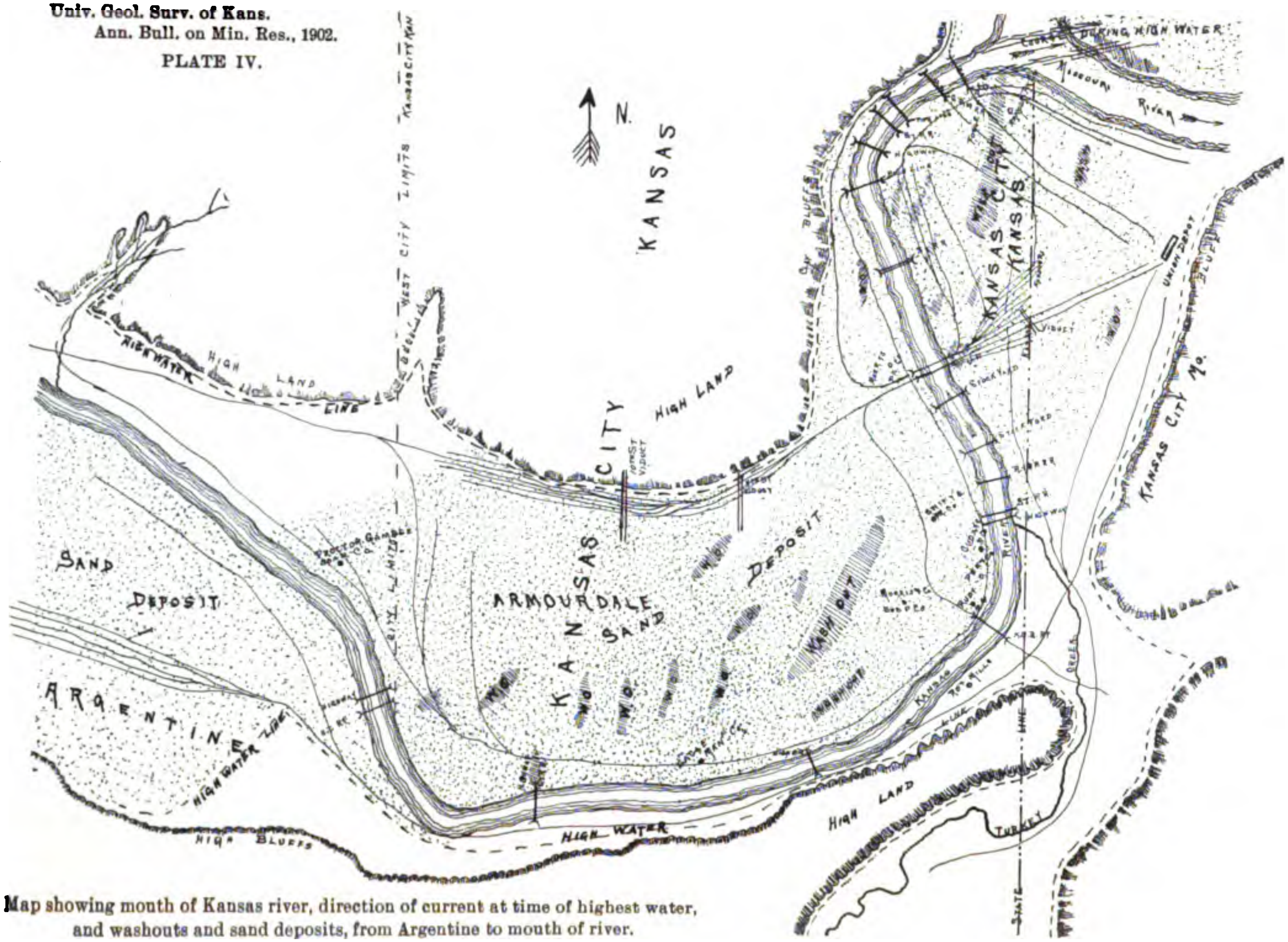
FIG. 8. Corrasion and types produced by boulders lodged along small streams.

to currents of water rushing upwards through a deep mass of sand. The writer remembers an experience in the Missouri river quicksand. When waist deep in water he was caught in quicksand and, to test his theory, allowed himself to sink down until the water reached his chin before trying to get out. He could feel plainly the sand being washed out from beneath his feet and packing above around his legs. The upward lifting of a foot allowed a rush of water upward, which cut out the sand beneath, while the sand only packed the more tightly above. The quicksand was finally cleared away by leaning the body considerably up stream, so that the free current cut out the sand from above, as in the case of the inclined telegraph poles mentioned, by being directed downwards, so as to counteract the upward rush of water. Another swimmer similarly caught at the same time was with difficulty released by a boatman.

At this place in the river a very heavy sand-bar apparently allowed the water to run through it, only to come up again at the lower end with almost sufficient force to loosen and raise

the sand. If at the lower end of any large sand-bar one will slowly rock one's feet upon the moist sand, although several inches above water level, it will generally be possible to get a slight upward rush of sand and water, if the stream be at all swift around the bar and the sand of a loose nature. This shows that some of the water is flowing through the sand and coming up at the lower end of the bar.

PLATE IV.



Map showing mouth of Kansas river, direction of current at time of highest water, and washouts and sand deposits, from Argentine to mouth of river.

Flood scene, May-June, 1903. Manhattan. Inundated portions. The camera was placed on the high hill-point north of the city, and directed towards the southeast. Bluffs in distance are south of the river. Blue river, near its mouth, is seen at the left, with the Kansas river near the bluffs. Photographed by S. C. Orr.

Street scene in Manhattan during the flood of May-June, 1903. Photographed by S. C. Orr.

Result of May-June flood, 1903. Scene of first new channel above Manhattan, Allingham bend. The new channel is seen on left; the old follows timber in distance and comes back south to front of view. See, also, plate III. Photographed by S. C. Orr.

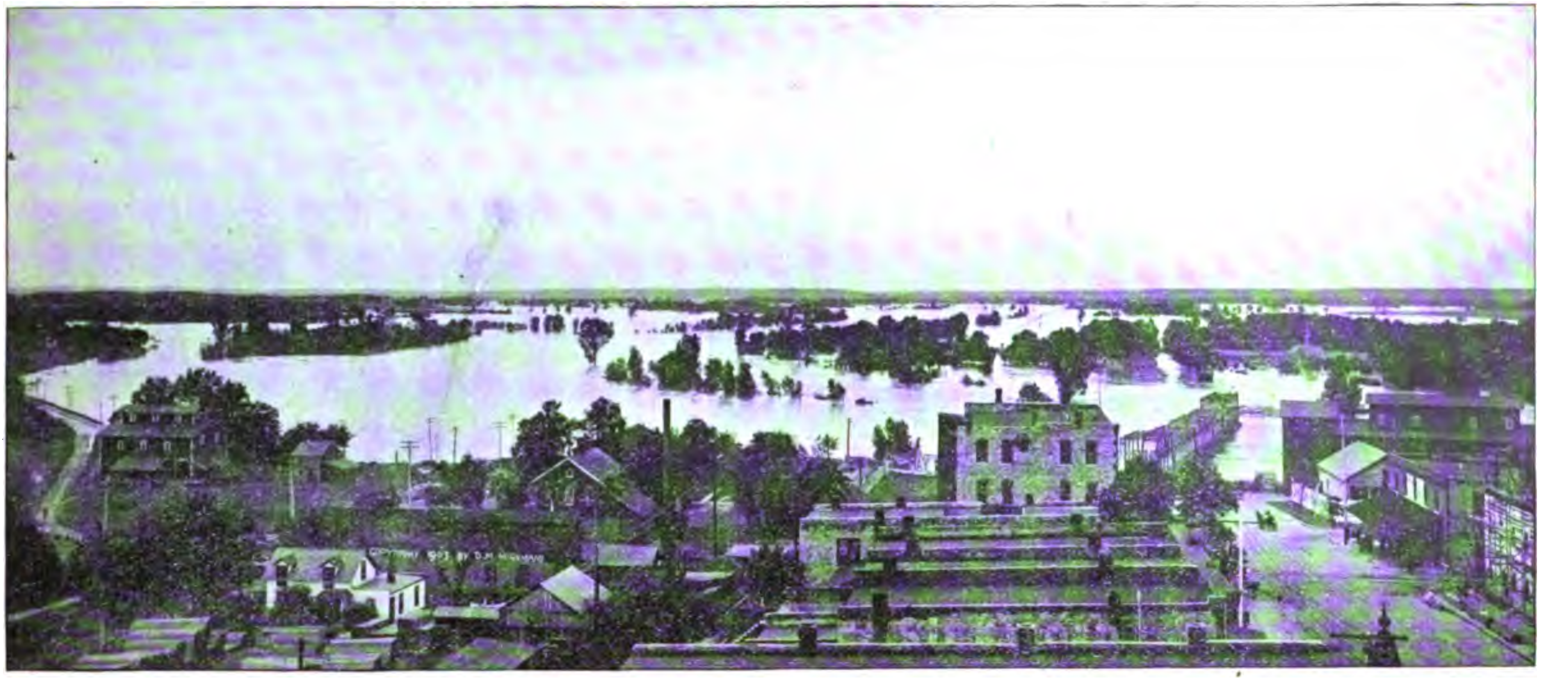
Near-by view of a washout, flood of May-June, 1903. Near Manhattan, Allingham bend. Photographed by S. C. Orr.

Flood scene, May-June, 1903. Fire station, North Topeka, after water had receded five feet.
Photographed by C. M. Smyth.

Flood scene, May-June, 1903. North Topeka, Quincy street, looking north from W. H. Troutman's.
Photographed by C. M. Smyth.

Flood scene, May-June, 1903. Union Pacific park, North Topeka. Photographed by C. M. Smyth.

Flood scene, May-June, 1903. Topeka, residence portion. Foot of Quincy street, near the Wolff packing plant. Photographed by Strickrott.



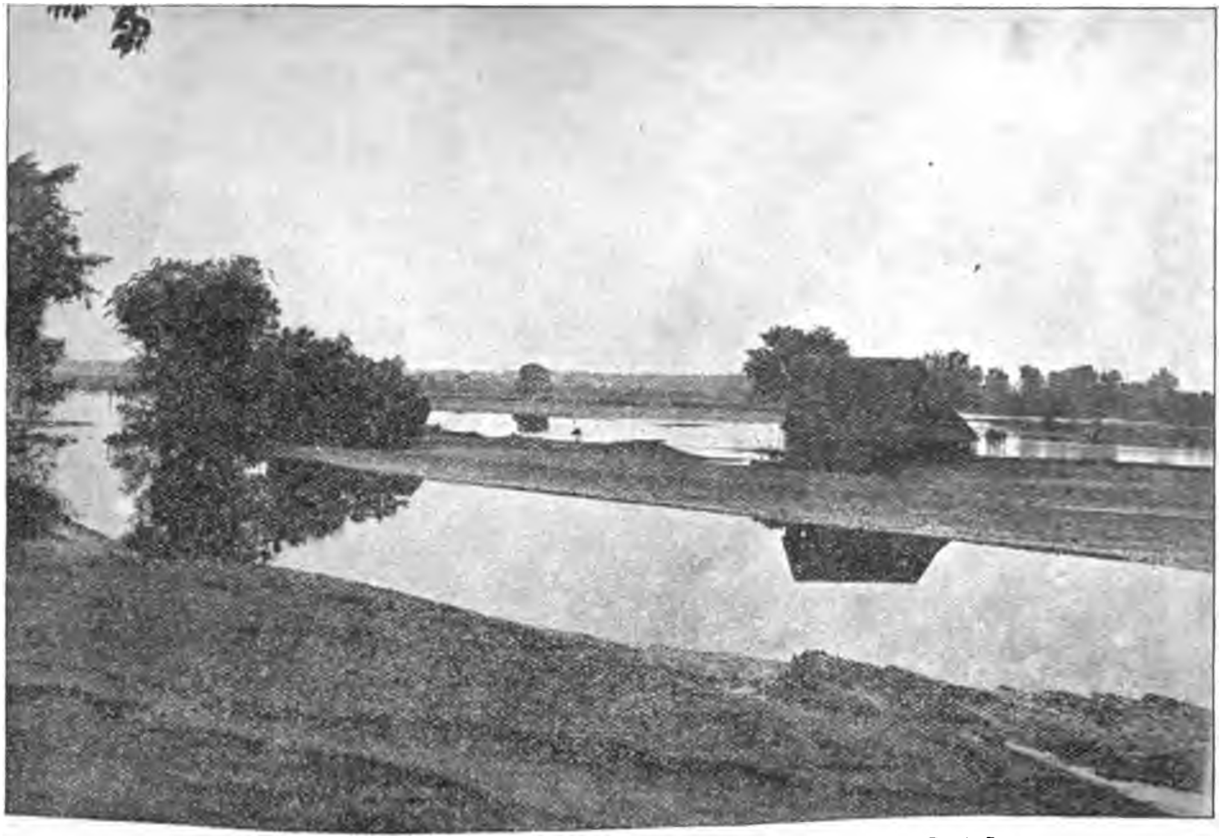
Flood scene, May-June, 1903. Lawrence. Camera on top of First National Bank building, directed up stream. A portion of Massachusetts street and the wagon bridge is seen on the right. Water extends entirely to bluffs on the north. Photographed by Horkman.

Flood scene, May-June, 1903. Lawrence. North platform at Santa Fe passenger depot. Photographed by Horkman.

Flood scenes, May-June, 1903. North Lawrence. Union Pacific passenger depot. Photographed by Horkman.

New channel near Desoto. Looking up stream. Photographed by Dr. A. J. Lee.

New channel near Desoto. Looking north. Photographed by Dr. A. J. Lee.



New channel near Desoto. At foot of channel, looking northwest. Photographed by Dr. A. J. Lee.

New channel near Desoto. Looking east. Photographed by Dr. A. J. Lee.

Flood scene. Lenape, one week after highest water. Photographed by Dr. A. J. Lee.

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ON THE

MINERAL RESOURCES

OF KANSAS,

1903,

INCLUDING A REPORT UPON LEAD AND ZINC, COAL, OIL, GAS, CLAY PRODUCTS, GYPSUM, HYDRAULIC AND PORTLAND CEMENTS, BUILDING STONE, AND SALT.

BY ERASMUS HAWORTH,
State Geologist.

LAWRENCE, KANSAS,
JUNE, 1904.

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LETTER OF TRANSMITTAL.

Dr. Frank Strong, Chancellor of the University of Kansas:

DEAR SIR—I have the honor to submit herewith my annual report for the year 1903 on the mineral resources of Kansas, which will constitute the sixth annual bulletin of this series. It affords me pleasure to state that the mining and metallurgical interests of the state during the year 1903 were by far the most prosperous ever known, the total aggregate of business done being more than twenty per cent. greater than in any previous year. This great increase is due, principally, to a general increase in production, and in a much lesser degree to an increase in prices.

Yours most respectfully,

ERASMUS HAWORTH,
State Geologist.

DEPARTMENT OF GEOLOGY AND MINERALOGY,
UNIVERSITY OF KANSAS, June, 1904.

CONTENTS.

INTRODUCTION.

DURING the calendar year 1903 the mining and metallurgical industries of Kansas were by far the most prosperous of any year in the state's history. A general summary of production is given in table I, which shows a total valuation of $27,-154,007.85. This is nearly five millions greater than for the year 1902, which, in turn, was the largest the state had yet produced. The increase is, therefore, more than twenty per cent., a remarkably good showing.

For the first time in years, no interest has been manifested in mining or smelting gold or silver. All the reported discoveries have proved to be failures, and no new discoveries were made. It is true some mining operations were carried on in Smith county during the early part of the year, as was mentioned in this report for 1902, but early in the spring such work was discontinued, and nothing more has been done in this line anywhere else in the state. Also, the only smelter making an attempt at gold and silver extraction, one of the zinc smelters at Iola, has abandoned the enterprise as unprofitable. The plant of the erstwhile gold and silver refining company at Argentine has been torn down and removed, leaving no operations of any kind anywhere in the state bearing on gold and silver production. For this reason the subject is dropped from the table of contents of this year's report.

Lead and zinc mining was conducted in about the same way it was for 1902, the output being slightly reduced, and the total valuation for the same falling a little below the figures for the previous year. A larger amount of spelter, however, was smelted on Kansas soil, a larger amount of natural gas for zinc smelting having been used than ever before. Coal mining witnessed a great increase, the amount reaching nearly 6,000,000 tons.

Also, the market price of coal was the highest known for many years, so that the total valuation of coal reached almost $10,000,000. The only new developments were in the Cretaceous coal of Jewell county, where two new mines were in operation during the entire winter of 1903–'04.

The most remarkable increase in production and mining activity was witnessed in the oil fields and gas fields of the southeastern part of the state. Up to 1902 the total production of oil rarely reached 100,000 barrels per annum. In 1902 it was more than 300,000 barrels, while in 1903 it was more than 1,000,000 barrels, with the production increasing at a remarkably rapid rate. The developments during the year resulted in a surprisingly great expansion of productive territory. It reached west into Chautauqua and Woodson counties, north into Allen and Miami counties, and the individual areas everywhere were greatly extended.

The manufacture of different kinds of products from clay was greatly increased. All the brick factories were operated on a larger scale than ever before, and quite a number of new enterprises, such as the pressed-brick plant at Iola, the roofing-tile factory at Coffeyville, the pottery factory at Coffeyville, and others, gave a greater increase in variety of production than was made in any one previous year.

The production of plaster from gypsum is less than for the previous year, and prices were maintained about the same. The gypsum-earth deposits of the state are almost exhausted, so that the mills are operated principally on rock gypsum. No new hydraulic cement factories have been established, the only ones in the state being the two at Fort Scott, as has been the case for a number of years. The Portland cement industry was greatly expanded by the erection of a new plant at Iola by the Kansas Portland Cement Company. This plant was built during the year 1903, and at first was expected to begin operations in the early autumn. A longer time was occupied in its construction than had been contemplated, and the year was almost gone before the actual manufacture of cement was begun. The Iola Portland cement factory was in successful operation during the entire year.

TABLE I.

SHOWING VALUE OF EACH OF THE MINERAL PRODUCTS OF KANSAS FOR 1903, AND SINCE INDUSTRY BEGAN.

Name of Product.	Amount for 1903.	Value per unit.	Value for 1903.	Grand total of production since industry began.
NON-METALLIC PRODUCTS.				
Coal . . . . tons	5,985,000	$1 65	$9,875,250 00	$88,956,373 00
Coke	. . . .	. . . .	. . . .	475,000 00
Salt, without cooperage . . . . bbls.	1,455,582	50	800,730 74	9,089,376 51
Cooperage (estimated) . . . . bbls.	600,000	27	162,000 00	3,537,250 00
Clay products	. . . .	. . . .	1,141,156 00	6,199,241 00
Gypsum cement plaster . . . . tons	36,929	4 75	159,021 00	2,942,536 00
Stone, building (estimated) . . . . cu. yds.	. . . .	. . . .	638,240 00	6,528,456 00
Natural gas	. . . .	. . . .	1,115,375 00	4,475,616 00
Oil, crude . . . . bbls.	1,018,199	1 10	1,120,018 90	2,025,584 33
Hydraulic cement . . . . bbls.	. . . .	. . . .	75,897 50	1,047,527 00
Portland cement	730,000	1 10	803,000 00	3,928,000 00
Lime (estimated)	. . . .	. . . .	75,000 00	1,660,000 00
Sand (estimated)	. . . .	. . . .	100,000 00	1,850,000 00
METALLIC PRODUCTS.				
Zinc ore, 26,620.92 tons, worth $878,942.83, yielding metallic zinc . . . . tons	13,310.46	108 00	1,437,529 68	51,193,326 82
Lead ore, 3139.45 tons, worth $169,122.17, yielding metallic lead . . . . tons	2,197.62	84 74	186,226 31	
SMELTING PRODUCTS.				
Zinc smelting . . . . tons	87,634.84	108 00	9,464,562 72	65,317,603 40
Totals	. . . .	. . . .	$27,154,007 85	$249,325,890 06

The stone industry was conducted about as it has been in years past. The largest quarries in the state are in the vicinity of Cottonwood Falls, where the Cottonwood limestone is extensively quarried and shipped to all points in the western part of the Mississippi valley. Other quarries were operated on the same Cottonwood limestone, both north and south of Cottonwood Falls, particularly to the north at Eskridge, Manhattan, Frankfort, and similar places. The railroads consumed an unusually large amount of crushed stone for ballast, as there was a great activity in road-bed improvement throughout the state.

Salt-making was likewise very active. The largest production comes from Hutchinson, where evaporated salt is produced on a large scale. In addition, the plants at Anthony, Kingman, Sterling and Kanopolis were operated almost constantly. A new plant was built at Ellsworth for making evaporated salt, which began operations about the first of the year.

I.—LEAD AND ZINC.

IN 1903 Kansas produced a little less zinc ore and lead ore than during the previous year. The production was 26,620.92 tons zinc ore, and 3,139.45 tons of lead ore, with an aggregate value of $1,048,065 at the mines, as shown in table II. During the year the price of zinc ore varied from $32.10 per ton for 60 per cent. ore to $38.37, with an average of $35.05. Lead ore varied in value from $51, the average for February, to $57.48, the average for April, with an average for the entire year of $53.87. By comparing these figues with corresponding figures for 1902 it will be seen that the production of both lead ore and zinc ore was less for 1903 than for the previous year, and that the prices were higher, making the total value almost the same. In 1902 the state produced a little over 31,000 tons of zinc ore, against 26,000 in 1903, but the average price of 60 per cent. ore was $32, instead of a little over $35, as in 1903. The total amount of lead ore produced in 1903 was 4126.61 tons, against a little over 3000 tons for 1903, but the average price per ton was only $46.44, against $53.87 for 1903.

The falling off in production of both zinc ore and lead ore in Kansas is due principally to the fact that no new mines have been opened. The best ore-producing area necessarily is small. All the ore thus far produced in the state comes from the Sub-carboniferous or Mississippian limestones and flints, which cover a triangular surface in the extreme southeastern part of the state not exceeding six miles in width on the south line and ten miles in length on the east. Within this area of thirty square miles not more than five or six square miles have proven productive. It begins to look as though there never would be a very large increase in productive area, and, therefore, it is feared the total annual production for the future will have a tendency to decrease.

TABLE II.

SHOWING AMOUNT AND VALUE OF ZINC ORE AND LEAD ORE IN THE GALENA AREA
compared with amount and value of same ores for the whole Galena-Joplin area, 1903.
Data gathered from reports in *Engineering and Mining Journal.*

MONTH.	Product and value of Kansas area in 1903.					Product and value in Kansas and Missouri area in 1903.					Per cent. Kansas production of whole area, 1903.	
	Zinc ore. In tons (2000 lbs.) and dollars.		Lead ore. In tons (2000 lbs.) and dollars.		Total value.	Zinc ore. In tons (2000 lbs.) and dollars.		Lead ore. In tons (2000 lbs.) and dollars.		Total value.	Zinc ore.	Lead ore.
	Product.	Price.	Product.	Price.		Product.	Price.	Product.	Price.			
January	2,507.34	$32 10	264.88	$51 06	$92,192	19,088.71	$32 10	2,397.74	$51 06	$868,820	13.14	11.05
February	2,024.04	32 25	219.57	51 00	70,421	15,576.29	32 25	1,955.02	51 00	779,480	12.99	11.23
March	2,410.75	34 50	252.75	53 08	96,522	21,851.59	34 50	1,954.16	53 08	986,401	11.03	12.93
April	2,567.69	38 37	268.86	57 48	112,170	21,580.97	38 37	2,733.55	57 48	1,036,691	11.89	9.84
May	2,035.41	37 20	255.25	55 62	75,467	18,002.91	37 20	2,500.87	55 62	823,063	11.31	10.01
June	2,043.07	38 00	247.64	53 12	92,815	20,479.70	38 00	2,510.07	53 12	786,422	9.98	9.87
July	2,428.16	36 00	324.88	51 75	96,435	19,861.75	36 00	2,547.74	51 75	820,514	12.23	11.82
August	2,330.34	35 80	213.50	53 57	91,298	24,291.94	35 80	2,448.06	53 57	798,721	9.59	6.19
September	2,340.18	35 75	214 21	54 87	98,252	20,611.58	35 75	2,220.50	54 87	752,027	11.35	9.65
October	2,215.00	35 00	291.34	56 00	89,154	18,985.01	35 00	2,513.84	56 00	716,489	11.67	11.59
November	2,100.98	33 62	310.36	55 08	76,639	17,277.23	33 62	2,362.82	55 08	592,044	12.59	13.13
December	1,617.96	33 10	276.21	53 91	56,400	17,125.62	32 10	2,292.22	53 91	491,813	9.67	12.05
Totals and averages,	26,620.92	$35 05	3,189.45	$53 87	$1,048,065	234,733.85	$35 05	28,436.59	$53 87	$9,452.485	11.45	10.78

Table II shows the entire production for the Galena-Joplin area. The total tonnage of zinc ore was 234,733.35 tons, and the total lead ore production was 28,436.59 tons. Of this amount Kansas produced 11.54 per cent. of the zinc ore and 9.95 per cent. of the lead ore. A comparison of this table with similar tables published in recent years shows that recently there has been relatively a falling off in Kansas compared with the entire Galena-Joplin area. In 1903 it was 11.45 for zinc ore and 10.78 for lead ore. In 1902 it was 11.99 for zinc ore and 13.64 for lead ore. In 1901 it was 13.34 for zinc ore and 13.99 for lead ore. In 1900 it was 18.30 for zinc ore and 17.22 for lead ore. In 1899 it was 24.24 for zinc ore and 27.48 for lead ore. In 1898 it was 33.28 for zinc ore and 32.63 for lead ore. It will be seen, therefore, that the decline in per cent. of production

TABLE III.

SHOWING OUTPUT OF ZINC AND LEAD ORES, GALENA DISTRICT, KANSAS.

From January 1, 1886, to December 31, 1903, inclusive. Data since 1895 from the *Engineering and Mining Journal*; others from Mr. Russell Elliott, Galena.

YEAR.	ZINC ORE.			LEAD ORE.			Total value of output.
	Tons (2000 lbs.)	Average price per ton, 60% ore.	Value.	Tons (2000 lbs.)	Average price per ton.	Value.	
1886..	31,768.00	$18 50	$587,708 00	2,962.14	$59 00	$174,766 38	$762,474 38
1887..	32,795.00	19 00	623,105 00	3,073.19	52 50	161,499 98	784,604 98
1888..	33,391.00	21 00	701,211 00	2,624.00	31 00	81,344 00	782,555 00
1889..	32,950.00	24 00	790,800 00	3,992.50	46 00	183,655 00	974,455 00
1890..	21,675.00	23 00	498,525 00	4,173.96	42 28	176,176 28	674,701 28
1891..	20,641.00	21 51	454,102 00	3,602.21	50 32	182,271 33	636,373 33
1892..	23,811.00	20 00	476,237 78	7,188.17	42 00	301,903 14	778,140 92
1893..	25,028.00	18 85	471,789 00	5,139.59	38 00	195,314 42	667,103 42
1894..	28,670.00	17 10	490,257 00	5,817.49	33 64	195,794 56	686,051 66
1895..	41,232.00	19 68	812,792 00	12,537.64	38 56	482,548 75	1,295,340 75
1896..	62,232.00	22 51	1,401,307 83	14,061.58	32 04	450,529 90	1,851,837 73
1897..	59,457.00	25 17	1,492,663 04	15,184.68	50 20	762,469 96	2,255,133 00
1898..	74,852.00	26 64	1,994,230 55	7,918.28	42 04	352,798 45	2,347,029 00
1899..	64,708.48	38 54	2,313,831 00	6,723.40	52 62	354,311 00	2,668,142 00
1900..	46,501.35	30 28	1,238,237 13	4,938.44	48 80	240,995 87	1,479,233 00
1901..	33,997.80	27 95	797,844 37	5,238.19	46 94	245,880 63	1,043,725 00
1902..	31,225.30	32 00	898,184 23	4,126.61	46 44	191,639 77	1,089,824 00
1903..	26,620.92	35 05	878,942 83	3,139.45	53 87	169,122 17	1,048,065 00
Totals for 18 years..	691,529.85	$24 48	$16,921,767 76	112,444.52	$44 79	$4,903,022 19	$21,824,789 95

has been gradual. This is partly due to the actual decrease in tonnage at Galena, but more largely to the large and ever increasing productive area of Missouri. The lead- and zinc-bearing formations cover an area in Missouri aggregating many hundreds of square miles, instead of a small area like that in Kansas. New mines opening up every year compensate in great part for the decline in production at the old mines.

Table III exhibits the annual production of lead ore and zinc ore in the Galena district for eighteen years, from 1886 to 1903, inclusive, with average yearly price of 60 per cent. zinc ore and of lead ore. It will be noted that the largest value of the total production of any one year was in 1899, followed closely by the two preceding years, 1898 and 1897. Since the year 1899, the tonnage and total value have greatly decreased. Tables IV and V give a comparative statement of the value of ores at the mines and of the metallic products at New York prices. It is interesting to observe whether or not ore prices fluctuate with metal prices. An examination of these two tables shows to what extent this was true for the entire period from 1888 to 1903, inclusive. Table VI shows the price per ton of zinc blende at the mines, the price per ton of metallic zinc, New York prices, the ratio between the two, the price per ton of metallic zinc in 60 per cent. ore before smelted, and the total difference between the value of the metal in the ore and its value after smelting. This total difference given in the right-hand column, therefore, must include all loss, expense of purchase, shipments, cost of smelting, and profits to the smelters.

There is a perennial conflict between the ore producers and the smelters or ore buyers. In 1899 a strong organization was effected by the ore producers of the entire Galena-Joplin area, with the intention of regulating the prices of ore as far as they could. On a number of occasions they have called for a complete shut-down in mining operations in order that the overproduction might not be used to reduce ore prices. At other times they have exported ores, sometimes at a loss compared with local prices, and sometimes at a small profit.

TABLE IV.

SHOWING COMPARATIVE VALUES PER TON (2000 LBS.) OF ZINC ORE IN GALENA-JOPLIN AREA AND METALLIC PRODUCTS IN NEW YORK.

MONTH.	1898.		1899.		1900.		1901.		1902.		1903.	
	Ore.	Spelter.	Ore.	Spelter.	Ore.	Spelter.	Ore.	Spelter.	Ore.	Spelter.	Ore.	Spelter.
January	$23 25	$79 20	$40 25	$106 80	$35 13	$93 00	$27 00	$82 60	$27 00	$85 40	$32 10	$97 20
February	22 62	80 80	43 37	125 60	34 50	92 80	27 25	80 20	27 50	83 00	32 25	100 80
March	22 50	90 00	43 40	126 20	32 60	92 00	27 20	78 20	29 50	85 60	34 50	106 80
April	27 30	85 20	51 50	133 40	32 88	94 20	28 38	79 60	31 40	87 40	38 37	111 00
May	25 50	85 40	50 50	137 60	30 63	90 60	28 38	80 80	30 00	89 40	37 20	112 60
June	28 00	95 40	45 50	119 60	27 80	85 80	27 80	79 80	32 50	99 20	38 00	113 80
July	27 90	93 20	44 20	116 40	27 50	85 60	26 65	79 00	37 00	105 40	36 00	113 20
August	27 00	91 60	45 00	113 00	28 38	83 40	26 87	79 80	35 25	108 80	35 80	114 40
September	30 50	93 40	43 75	110 00	27 70	82 20	26 25	81 60	34 00	109 80	35 75	113 16
October	24 40	99 60	43 50	106 40	28 50	83 00	28 00	84 60	35 25	107 60	35 00	110 20
November	34 75	105 80	35 00	92 80	28 88	85 80	29 00	85 80	33 50	103 60	33 62	106 60
December	36 10	102 00	36 00	93 20	28 95	85 00	31 62	85 75	31 00	95 60	32 10	94 60
Averages	$27 49	$91 80	$43 50	$115 08	$30 29	$87 80	$27 87	$81 48	$32 00	$96 80	$35 05	$108 00

TABLE V.

SHOWING COMPARATIVE VALUES PER TON (2000 LBS.) OF LEAD ORE IN GALENA-JOPLIN AREA AND METALLIC PRODUCTS IN NEW YORK.

MONTH.	1898.		1899.		1900.		1901.		1902.		1903.	
	Ore.	Pig lead.	Ore.	Pig lead.	Ore.	Pig lead.	Ore.	Pig lead.	Ore.	Pig lead.	Ore.	Pig lead.
January......	$44 00	$73 00	$47 88	$83 60	$55 50	$93 60	$55 66	$87 00	$42 00	$80 00	$51 06	$81 50
February.....	43 50	74 20	53 00	89 80	55 38	93 50	45 00	87 00	43 50	81 50	51 00	81 50
March........	46 24	74 40	51 60	87 40	54 90	93 50	46 30	87 00	43 26	81 50	53 08	88 84
April.........	43 20	72 60	44 50	86 20	54 12	93 50	45 62	87 00	43 50	81 50	57 48	91 34
May..........	43 50	72 80	52 00	88 80	51 50	83 62	46 00	87 00	44 10	81 50	55 62	86 50
June	45 74	76 40	52 00	88 60	43 10	78 02	47 30	87 00	45 35	81 50	53 12	84 20
July..........	45 20	79 00	53 80	90 40	45 24	80 60	47 26	87 00	48 20	81 50	51 75	81 50
August.......	46 12	80 00	54 50	91 40	46 12	85 00	47 00	87 00	49 00	81 50	53 57	81 50
September....	47 00	79 80	54 00	91 60	45 80	87 00	46 12	87 00	49 00	81 50	54 87	84 86
October	46 90	75 60	53 80	91 50	46 00	87 00	46 50	87 00	49 37	81 50	56 00	87 50
November	42 16	74 00	54 40	91 50	46 00	87 00	46 50	87 00	50 00	81 50	55 08	84 36
December	40 00	75 20	54 00	92 80	46 00	87 00	44 00	84 02	50 00	81 50	53 91	83 24
Averages...	$44 46	$75 58	$52 12	$89 47	$49 14	$87 45	$46 94	$86 75	$46 44	$81 38	$53 87	$84 74

Table VI exhibits the actual relations as they have existed, and, therefore, becomes an important table of comparison. In one sense it is an extension of tables IV and V, although it expresses the same facts in a different manner. It will be noted that the ratio between the price of ore per ton and of metallic zinc in 1886 was 1 : 4.69. For a number of years the ratio remained about the same, but in 1890 it increased to 1 : 4.72 and in 1891 to 1 : 5.05. During these years metallic zinc was high and ore ruled exceedingly low. Strangely, in 1890 it was higher than in 1891. By 1896 the ratio had decreased to 1 : 3.54. This was after the beginning of agitation for an organization by ore

TABLE VI.

SHOWING PRICE PER TON OF ZINC BLENDE AT GALENA-JOPLIN

From 1886 to 1903, inclusive, and price per ton of metallic zinc in New York, with ratio between the two; also, price per ton of metallic zinc in 60-per-cent. zinc ore and difference between this and New York price.

YEAR.	Price per ton of zinc blende in Galena-Joplin. (2000 lbs.)	Price per ton of metallic zinc in New York. (2000 lbs.)	Ratio between price of zinc blende and metallic zinc.	Price per ton of metallic zinc in 60-per cent. ore. (2000 lbs.)	Difference between price per ton of metallic zinc in 60-per-cent ore and New York price.
1886.........	$18 50	$87 90	1:4.69	$30 83	$57 07
1887.........	19 00	92 80	1:4.88	31 67	61 13
1888.........	21 00	98 34	1:4.68	35 00	63 34
1889.........	24 00	100 20	1:4.17	40 00	60 20
1890.........	23 00	108 75	1:4.72	38 33	70 42
1891.........	21 51	108 82	1:5.05	35 85	72 97
1892.........	20 00	89 78	1:4.48	33 33	56 45
1893.........	18 85	80 37½	1:4.28	31 42	48 95
1894.........	17 10	70 43	1:4.09	28 17	41 26
1895.........	19 68	71 04	1:3.60	32 80	38 24
1896.........	22 51	79 70	1:3.54	37 45	42 25
1897.........	25 17	82 40	1:3.27	41 82	40 58
1898.........	27 63	91 40	1:3.30	46 05	45 35
1899.........	38 54	115 00	1:2.98	64 23	50 77
1900.........	30 28	87 80	1:2.89	50 47	37 33
1901.........	27 95	81 50	1:2.91	46 58	34 92
1902.........	32 00	96 80	1:3.025	53 33	43 47
1903.........	35 33	108 00	1:3.056	58 88	49 12
Averages for 18 years....	$24 55	$91 72	1:3.73	$38 23	$50.77

producers, and also after the number of smelters had greatly increased. The ratio continued to decline, going below the point 1 : 3 for the first time in 1899 and reached its highest point in 1900. In 1901 there was a slight increase, and in 1902 it got above the 1 : 3 point and was still higher in 1903. The same general condition is shown in the fifth column, where the actual surplus is expressed. In 1886 there was a margin of $57.07 to cover all expenses as above stated. This margin increased, un-

TABLE VII.

SHOWING AMOUNT AND VALUE OF METALLIC ZINC PRODUCED AT KANSAS SMELTERS, 1882 to 1903, INCLUSIVE.

Price per ton in New York.

(Data 1882 to 1896 from United States Geological Survey statistics.)

YEAR.	Amount in short tons (2000 pounds).	Price per ton in New York.	Total value.
1882	7,366	$110 60	$814,679 60
1883	9,010	90 60	816,306 00
1884	7,859	89 60	704,466 40
1885	8,502	86 80	737,973 60
1886	8,932	87 90	785,122 80
1887	11,955	92 80	1,109,424 00
1888	10,432	98 34	1,025,902 88
1889	13,658	100 20	1,368,531 60
1890	15,199	108 75	1,652,891 25
1891	22,747	108 82	2,475,336 96
1892	24,715	89 78	2,218,912 70
1893	22,815	80 37½	1,733,755 63
1894	25,588	70 43	1,902,162 84
1895	25,775	71 04	1,831,056 00
1896	20,759	79 70	1,653,592 30
1897	33,443	82 40	2,755,703 20
1898	38,543	91 40	3,508,524 27
1899	52,664	115 00	6,056,360 00
1900	57,876	87 80	5,028,832 80
1901	81,542.30	81 50	6,645,697 45
1902	87,325.50	96 80	8,453,108 40
1903	87,634.84	108 00	9,464,562 72
	674,340.64	....	$62,742,603 40
Estimation of zinc smelted previous to 1882			2,575,000 00
Grand total			$65,317,503 40

TABLE VIII.

SHOWING AVERAGE MONTHLY AND YEARLY PRICE OF METALLIC ZINC—"SPELTER" IN NEW YORK FROM 1893 TO 1903, INCLUSIVE.

(Partly from *Engineering and Mining Journal.*)

YEAR.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	cts.	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*
1893.............	4.39	4.39	4.28	4.38	4.41	4.27	4.13	3.89	3.69	3.68	3.65	3.80	**4.08**
1894.............	3.56	3.85	3.89	3.62	3.37	3.40	3.43	3.38	3.44	3.45	3.36	3.43	**3.52**
1895.............	3.28	3.20	3.23	3.30	3.50	3.65	3.75	4.15	4.30	4.10	3.55	3.49	**3.63**
1896.............	3.75	4.03	4.20	4.09	3.98	4.10	3.97	3.76	3.60	3.72	3.99	4.14	**3.94**
1897.............	3.91	4.02	4.12	4.13	4.21	4.21	4.32	4.26	4.18	4.17	4.03	3.89	**4.12**
1898.............	3.96	4.04	4.25	4.26	4.27	4.77	4.66	4.58	4.67	4.98	5.29	5.10	**4.57**
1899.............	5.34	6.28	6.31	6.67	6.88	5.98	5.82	5.65	5.50	5.32	4.64	4.66	**5.75**
1900.............	4.65	4.64	4.60	4.71	4.53	4.29	4.28	4.17	4.11	4.15	4.29	4.25	**4.39**
1901.............	4.13	4.01	3.91	3.98	4.04	3.99	3.95	3.99	4.08	4.23	4.29	4.29	**4.07½**
1902.............	4.27	4.15	4.28	4.37	4.47	4.96	5.27	5.44	5.49	5.38	5.18	4.78	**4.84**
1903.............	4.86	5.04	5.34	5.55	5.63	5.69	5.66	5.72	5.68	5.51	5.33	4.73	**5.40**
Av. for 11 yrs.,	4.19	4.33	4.40	4.46	4.48	4.48	4.48	4.45	4.43	4.42	4.33	4.23	**4.39**

TABLE IX.

SHOWING WORLD'S PRODUCTION OF METALLIC ZINC FRON 1884 TO 1903, INCLUSIVE.

From Nineteenth Annual Report Director United States Geological Survey, part VI, pp. 223 and 224; foreign figures reported by Henry M. Merton & Co., London, England. Figures since 1898 from *Engineering and Mining Journal.*

YEAR.	Rhine district and Belgium.	Silesia.	Great Britain.	France and Spain.	Austria.	Poland.	Total foreign.	America.	Grand total.	Per cent. American.
1884	127,240	76,116	29,259	15,341	6,170	4,164	260,290	34,414	294,704	8.56
1885	129,754	79,623	24,299	14,847	5,610	5,019	259,152	36,329	292,659	8.05
1886	129,020	81,630	21,230	15,305	5,000	4,145	256,330	38,072	294,402	12.93
1887	130,995	81,375	19,839	16,028	5,388	3,580	257,155	44,946	302,101	14.87
1888	133,245	83,375	26,783	16,140	4,977	3,785	268,305	49,913	318,218	15.68
1889	134,648	85,665	30,806	16,785	6,330	3,026	277,248	52,553	329,801	16.23
1890	137,630	87,475	29,145	18,240	7,135	3,620	283,245	57,860	341,105	16.96
1891	139,695	87,080	29,410	18,360	6,440	3,760	284,745	72,208	356,953	20.22
1892	143,305	87,760	30,310	18,662	5,020	4,270	289,327	77,910	367,237	21.21
1893	149,750	90,310	28,375	20,585	7,560	4,530	301,110	70,385	371,495	18.93
1894	152,420	91,145	32,065	21,245	8,580	5,015	310,470	67,257	377,727	17.80
1895	172,135	93,620	29,495	22,895	8,355	4,960	331,460	80,077	411,537	19.45
1896	179,730	95,875	25,880	28,450	9,255	6,165	345,355	72,767	418,122	17.43
1897	184,455	94,045	23,430	32,120	8,185	5,760	347,995	89,268	437,263	20.41
1898	191,836	99,233	27,635	32,649	7,229	5,664	364,246	103,515	467,761	22.10
1899	192,994	100,160	32,223	33,482	7,305	6,325	372,496	123,194	495,690	26.87
1900	189,994	102,316	30,307	44,200	6,836	5,969	288,525	122,885	411,375	29.86
1901	223,199.2	119,151.2	32,692 8	30,536.8	8,624	6,647.2	420,851.2	140,822	561,673.2	25.07
1902	220,616	127,074	44,361.3	29,795	8,744.4	8,983	439,603.7	158,237	597,840.7	26.47
1903	....	....	....	....	....	....	....	....	....	....

til in 1890 and 1891 it was from over $70 almost to $73, corresponding exactly with the high ratio expressed in column 3.

From this time down to the present, in general the figures have declined; not regularly, however. During the last three years there has been a slight increase, exactly as there has been in the ratio shown in column 3, so that for the year 1903 there was a margin of $49.12 on every ton of spelter produced.

At the present time there is an unusual interest attached to zinc smelting on account of the starting up of coal smelters in a number of different places. When natural gas came into use for zinc smelters it was thought it would drive the coal smelters out of existence. Apparently it did so, as the year 1902 and 1903 witnessed practically no smelting in coal furnaces in this part of the country. But late in 1903 and in the early spring of 1904 coal smelters again seemed to be coming into demand. Just what this implies is difficult to tell. Table IV implies that the margin for profits is sufficiently great to permit their successful operation. The question naturally may be asked: Why do not the ore producers smelt their own ore? In discussing this subject with different producers, the writer has been informed frequently within the last two years that, with ore prices as they are and spelter as it is, it is more profitable to devote their energies to the production of ores than it would be to divide them between ore production and ore smelting. Quite likely this was true in 1899, 1900 and 1901. But certainly, with a margin for profit and loss in smelting of nearly $50, the ore producers might well examine into the subject with a little greater care.

II.—COAL.

NEVER before in the history of the state have our coal-mines been so productive as they were in 1903, nor prices so high in recent times. The total tonnage produced was 5,985,000 tons, with an average value at the mines of $1.65 per ton. As usual, Crawford county was the heaviest producer, with Cherokee county a close second. These were followed by Leavenworth and Osage counties, in the order named, and they in turn by fourteen or fifteen other counties which produced only small amounts.

The most important development during the year was the reopening of an old mine in Jewell county. The mine near Jewell City was closed late in 1902 on account of an accident resulting in the death of the mine superintendent. The mine remained closed during the remainder of that winter, but early in the autumn of 1903 it was opened up, a new shaft sunk, and mining continued during the entire winter of 1903–'04. Likewise, an old mine at Formosa, two miles south of Montrose, in the eastern part of Jewell county, was unwatered in the autumn of 1903, and mining operations conducted throughout a greater part of the winter. This mine was first opened in 1888 or 1889, and was operated for a short time, supplying a wagon trade for the surrounding country.

Considerable time was spent during the summer in investigating this Jewell county Cretaceous coal. There can be but little doubt but that it has a sufficient extent to justify mining operations being conducted in a number of places in the northwestern part of the state. Its western extension is not known in detail, but, according to reports received from citizens of Mankato in 1886, a well was drilled half a mile south of that town on the farm of Mr. Mets which showed a fair amount of

coal at a depth of 446 feet. The hole was made with an auger similar to a wood-boring auger. The driller reported that the coal was four feet in thickness, but it is hardly probable it could be quite so thick. This would imply that the coal probably reaches as far west as Mankato, beyond which it is mere conjecture. Prospecting with the drill at Jewell City showed, however, that the coal at that point did not extend very far

TABLE X.

SHOWING COAL PRODUCTION IN SHORT TONS (2000 LBS.), 1880 TO 1903, INCLUSIVE.
With price per ton and value of yearly product.

YEAR.	Production in short tons (2000 pounds).	Price per ton.	Value of yearly product.
1880*	550,000	$1 30	$715,000
1881*	750,000	1 35	1,012,300
1882*	750,000	1 30	975,000
1883*	900,000	1 28	1,152,000
1884*	1,100,000	1 25	1,375,000
1885	1,440,057	1 23	1,770,270
1886	1,350,000	1 20	1,620,000
1887	1,570,079	1 40	2,198,110
1888	1,700,000	1 50	2,550,000
1889	2,112,166	1 48	3,126,005
1890	2,516,054	1 30	3,170,870
1891	2,753,722	1 31	3,607,375
1892*	3,007,276	1 31½	3,954,568
1893	2,881,931	1 37½	3,960,331
1894	3,611,214	1 35⅝	4,899,774
1895	3,190,843	1 12½	3,590,141
1896	3,191,748	1 01⅛	3,227,357
1897	3,291,806	1 07	3,488,380
1898	3,860,405	1 08½	4,193,159
1899	4,096,895	1 25	5,124,248
1900	4,269,716	1 28	5,500,709
1901	4,793,374	1 30	6,231,386
1902	5,230,267	1 36	7,139,139
1903	5,985,000	1 65	9,875,250
Totals	64,902,553	....	$84,456,373
Output previous to 1880	3,000,000	$1 50	4,500,000
Grand totals	67,902,553	....	$88,956,373

* Figures for 1880 to 1884, inclusive, and 1892, are taken from United States Geological Survey reports. All others are taken from reports of the State Inspector of Coal-mines.

west—only about two miles west of the mine. If coal underlies Mankato, it is quite likely the Mankato coal extends southwestward to the west of Jewell City. With prices as high as they have been for two years or more this Cretaceous coal becomes quite valuable. It can be mined and marketed at as great a profit, or probably greater, than any coal in the state.

With the exception of the Cretaceous coal above described, no new coal areas have been developed during the last ten years. The Pittsburg-Weir City coal has been extended, however, in almost every direction, and has been found in a number of places previously supposed to be barren. Late in 1902 it was discovered nearly four feet in thickness in the vicinity of Englevale, between Pittsburg and Fort Scott, on the Missouri Pacific railway. Also, it has been found in a number of places in Cherokee county where previously unknown; so that new mines are being opened up from time to time, greatly extending the workable area.

Coke.

Coke making in Kansas is confined principally to supplying coke to the zinc smelters. In the Cherokee-Crawford county district, where blasting is done in coal-mining, a large amount of slack coal is produced. This is used for making coke to supply the zinc smelters. Some years ago a coke furnace was built northwest of Columbus, in Cherokee county, at a point on the Missouri Pacific railway between Hallowell and Cherokee. A coal was found which made an excellent coke, and ovens were built with a capacity of three or four cars per day. As the management declines to give out statistics, it cannot be said what their capacity is or how much they produce. During the latter part of 1902 it was reported that the coal had developed into one of less value for coking, but no information can be obtained on this subject directly from the company.

Also, the Cherokee Coal Mining Company, at Cherokee, is mining an upper vein of coal which is capable of producing a good coke. The company erected two trial coke ovens—one of the common beehive type, twelve feet in diameter; the other of the type designed to save the by-products. The company sent

samples of its coke to various iron foundries and brass foundries, brick factories, bakeries, metal braziers, and others, who are reported to have pronounced it equal to the best Pennsylvania coke. It is particularly noted as having a high crushing strength, so that it will carry a heavy load in the furnace. In a circular sent out by the company, the following is given as the analysis of this coke:

Fixed carbon	88	per cent.
Volatile matter	0.43	"
Ash	11.56	"
Equaling	99.99	"
The ash contains, Sulphur	0.56	per cent.
The ash contains, Iron	1.30	"

The chemical analyses of coal from different mines in Cherokee and Crawford counties published in volume III, University Geological Survey of Kansas shows that a great deal of coal in this vicinity would be very serviceable for making coke. There can be no doubt but that, should a sufficient effort be made, this part of the state would furnish large quantities of coal well adapted to making a high-grade coke.

III.—OIL AND GAS.

THE oil and gas development in Kansas during the calendar year 1903 was very remarkable. The increase in production of gas was measured only by the demand for the same, as probably twice the amount consumed could have been furnished had the markets required it. The production of oil increased from 322,023 barrels in 1902 to 1,018,199 barrels in 1903. This statement of increase in production gives only a partial idea of the actual increase, on account of the fact that only a portion of the oil available was actually marketed. It was preeminently a year of prospecting and development, which means that there were many wells brought in and not yet connected with the pipe-lines. It may be said that if all the wells had been connected up with the pipe-lines, and their production marketed, the output would have been from fifty per cent. to to 100 per cent. greater than it was. No accurate figures are available for the number of wells completed at the close of 1902. Table XI shows the record of wells drilled during the last half-year for Kansas, and the Indian Territory as well. On July 1 there were a total of 725 wells drilled, and on December 31, there were 1590. Of this last number, Chanute had 549; Humboldt had 339; Neodesha had 280; Peru—all Chautauqua county—had 151; Independence, 111; Cherryvale, 49; Bartlesville, 77; Chelsea, 28, and Red Fork, 6.

The production of oil likewise was principally at the end of the year. Table XII exhibits the pipe-line runs for the year, as reported by the Neodesha agency of the Standard Oil Company. The Standard Oil Company took the greater part of the oil from the entire field, but by no means all of it. Mr. I. N. Knapp, of Chanute, did not begin selling them his oil until the year was nearly one-third gone; the Webster refinery

TABLE XI.—SHOWING OIL- AND GAS-WELLS COMPLETED AND ABANDONED, 1903.

Districts.	Wells producing, July 1	July.		August.		September.		October.		November.		December.		Total now producing
		Completed	Abandoned	Completed	Abandoned	Completed	Abandoned	Completed	Abandoned	Completed	Abandoned	Completed	Abandoned	
Chanute	306	45	....	16	....	25	....	25	1	81	2	56	2	549
Humboldt	133	14	....	35	17	65	21	68	15	44	16	65	16	339
Neodesha	161	18	5	35	12	18	5	29	9	39	2	23	10	280
Peru	32	9	1	30	10	32	11	25	4	30	7	29	3	151
Independence	7	10	7	36	18	8	4	32	11	49	10	25	6	111
Cherryvale	18	4	1	10	1	......	....	......	....	18	1	2	....	49
Bartlesville, I. T.	34	7	1	8	1	13	3	5	....	12	2	6	1	77
Chelsea, I. T.	33	......	....	......	....	......	....	......	....	......	....	......	5	28
Red Fork, I. T.	1	2	....	......	....	......	....	......	....	3	....	......	....	6
Totals	725	109	15	170	59	161	44	184	40	276	40	206	43	1,590

TABLE XII.—SHOWING PIPE-LINE RUNS FOR 1903.

MONTH.	Chanute.	Humboldt.	Neodesha.	Peru.	Independence.	Cherryvale.	Indian Territory and Oklahoma.	Totals.
January.....	25,811.40	....	7,440.38	2,975.06	....	1,154.87	7,146.76	44,528.47
February....	26,291.60	....	6,328.29	2,845.79	....	965.15	5,697.34	42,128.17
March.......	12,812.41	....	7,586.06	3,773.14	....	1,205.76	4,126.93	29,504.30
April........	9,965.90	....	6,706.38	3,036.34	....	425.56	7,033.88	27,168.06
May.........	46,033.57	431.00	9,305.74	2,634.15	....	1,083.23	4,277.78	63,765.47
June........	34,494.05	144.43	6,386.69	2,133.98	....	922.94	8,239.81	52,771.90
July.........	34,481.65	578.00	6,390.50	2,133.64	....	735.21	16,102.74	60,421.74
August......	67,822.28	....	10,838.35	3,272.90	....	1,353.24	10,490.69	93,777.46
September...	82,850.23	1,743.50	9,900.52	4,930.83	5,759.94	705.29	8,821.85	114,712.16
October.....	75,141.57	6,079.70	12,528.69	2,952.19	16,297.01	1,683.06	14,315.49	127,997.71
November...	74,175.44	6,743.22	19,821.00	11,987.89	34,776.54	3,634.35	24,613.01	175,751.45
December...	74,182.64	6,868.22	28,986.48	21,898.78	50,876.54	10,843.76	34,831.69	238,488.11
Totals.....	584,062 76	22,488.07	133,669 08	64,674.69	107,710.03	24,712.42	145,697.97	1,071,015.20

at Humboldt took about 200 barrels per day during the last of the year, and other amounts were marketed by wagon trade to the brick plants and other plants using large amounts of lubricating oils, which amounts in the aggregate make up for the apparent discrepancy between the amount given for Kansas and the total given in table XII.

Kansas has no very strong oil wells, if we compare them with the more noted "gushers" of America. The average wells in the Neosho valley at Chanute and Humboldt had an initial production of about twenty barrels, with 100 to 300 barrels' daily capacity for the strongest wells yet obtained. A few wells have been brought in which began at a considerably more rapid rate.

The developments have been so great and the geographic extent of the productive area so increased that special notice should be given.

ALLEN COUNTY.

Allen county has long been noted for its exceedingly rich gas fields, particularly in the vicinity of Iola and La Harpe. During the year 1903 no remarkable development of gas was brought about, although quite a number of good gas wells were brought in at different places in the county; but a veritable boom was witnessed in the oil fields of the southwest part of the county, in the vicinity of Humboldt. At the beginning of the year Humboldt had a few fair oil wells, particularly in the Neosho river valley near the south line of the county, an area usually spoken of as belonging to the Chanute fields. The development continued up the river from the south and down the river towards Chanute, until the Chanute fields and the Humboldt fields were practically united. It was carried westward as much as two miles west of the river, and eastward on the uplands to a distance of three or more miles farther east than Humboldt. The upland trend was carried southward across the county line into Neosho county, and contains some remarkable wells.

Another oil field was opened in the vicinity of Moran with moderate wells, producing oil of about the same quality as that obtained at Chanute and Humboldt. The wells are located on

both sides of the Missouri Pacific railroad, from the western limits of the town a distance of three miles toward La Harpe.

NEOSHO COUNTY.

The most remarkable development in Neosho county was in the vicinity of Chanute. Before the close of 1902, the river valley immediately to the east and northeast of Chanute was tolerably well prospected, with a number of wells producing oil. During the year 1903 development was carried on which rapidly extended the oil fields in every direction. Toward the north almost the entire valley was drilled; to the northeast on the uplands development reached northward to and connected with that in Allen county, and southward to the Neosho river in the vicinity of Shaw. At Shaw four or five good wells were brought in, situated a little north and west of the village, and two or three were obtained across the river south. Still farther to the southeast the Erie Oil, Gas and Mineral Company was engaged in active drilling operations throughout the entire year. Near the close of the year they reported thirty-five wells drilled, fourteen of which were gas wells, seven oil wells, and fourteen dry. Early in 1904 better success seems to have been obtained, as a number of wells to the northwest of Erie are reported to be very good oilers. South of Chanute small developments were made about Earleton, along the Santa Fe, and near Urbana, on the Missouri, Kansas & Texas. Also a few gas wells were obtained near Galesburg and to the west towards Thayer. Likewise, a few wells were drilled near Thayer which yielded a fair quantity of oil.

MONTGOMERY COUNTY.

The developments in Montgomery county are confined principally to the last half-year. Early in July the now famous Bolton field was opened up by a good well being obtained by Mr. Snyder, followed closely by another good well on the Banks land, in section 8, township 33 north, range 15 east, a few miles northeast of Bolton. This attracted prospectors, and in a short time the field was covered with derricks, and production became greater than in any other county in the state. Good oil was discovered north to beyond the Walker mound, almost

straight west from Independence, and a few fair wells were found northeast of Bolton, reaching down near Coffeyville. Interesting developments were also made in the Caney field, situated from two to six miles east of Caney, in the area lying between the Santa Fe railway track and the south line of the state. Here, also, a remarkable gas well was obtained, reported to have a capacity of over 15,000,000 cubic feet, making it the strongest gas well in the state to that date. Coffeyville, also, may be reckoned as oil producing territory. Nothing in the way of oil production was accomplished here until during the last half of the year. Southeast, east and northeast of the city shallow oil was found at a depth of from 350 to 400 feet, with some good wells obtaining oil from an oil sand about 600 feet below the surface. As no pipe line was laid to the Coffeyville field, almost no oil was marketed from here before the close of the year, but early in 1904 two or more companies began shipping oil by rail to Neodesha.

A few fair oil wells were also obtained in the vicinity of Wayside, and farther west, at Havana, sufficient to attract considerable attention, making it probable that there will be a fair production from this part of the county.

TABLE XIII.

PRODUCTION OF PETROLEUM IN KANSAS FOR 1886 TO 1903, INCLUSIVE.

Figures for 1889 to 1896, inclusive, are taken from the reports of the U. S. Geological Survey.

YEAR.*	Barrels.	YEAR.	Barrels.	Price per barrel.	Value.
1889......	500	1894......	40,000	48 cts.	$19,200 00
1890......	1,200	1885......	44,430	64 "	28,435 20
1891......	1,400	1896......	113,571	63 "	71,549 73
1892......	....	1897......	90,000	60 "	54,000 00
1893......	18,000	1898......	†88,000	$2 00	176,000 00
		1899......	85,215	75 cts.	52,167 00
		1900......	91,294	80 "	79,035 20
		1901......	169,197	80 "	135,357 60
		1902......	322,023	90 "	289,820 70
		1903	1,018,199	$1 10	1,120,018 90
		Totals..	2,083,029	97 cts.	$2,025,584 33

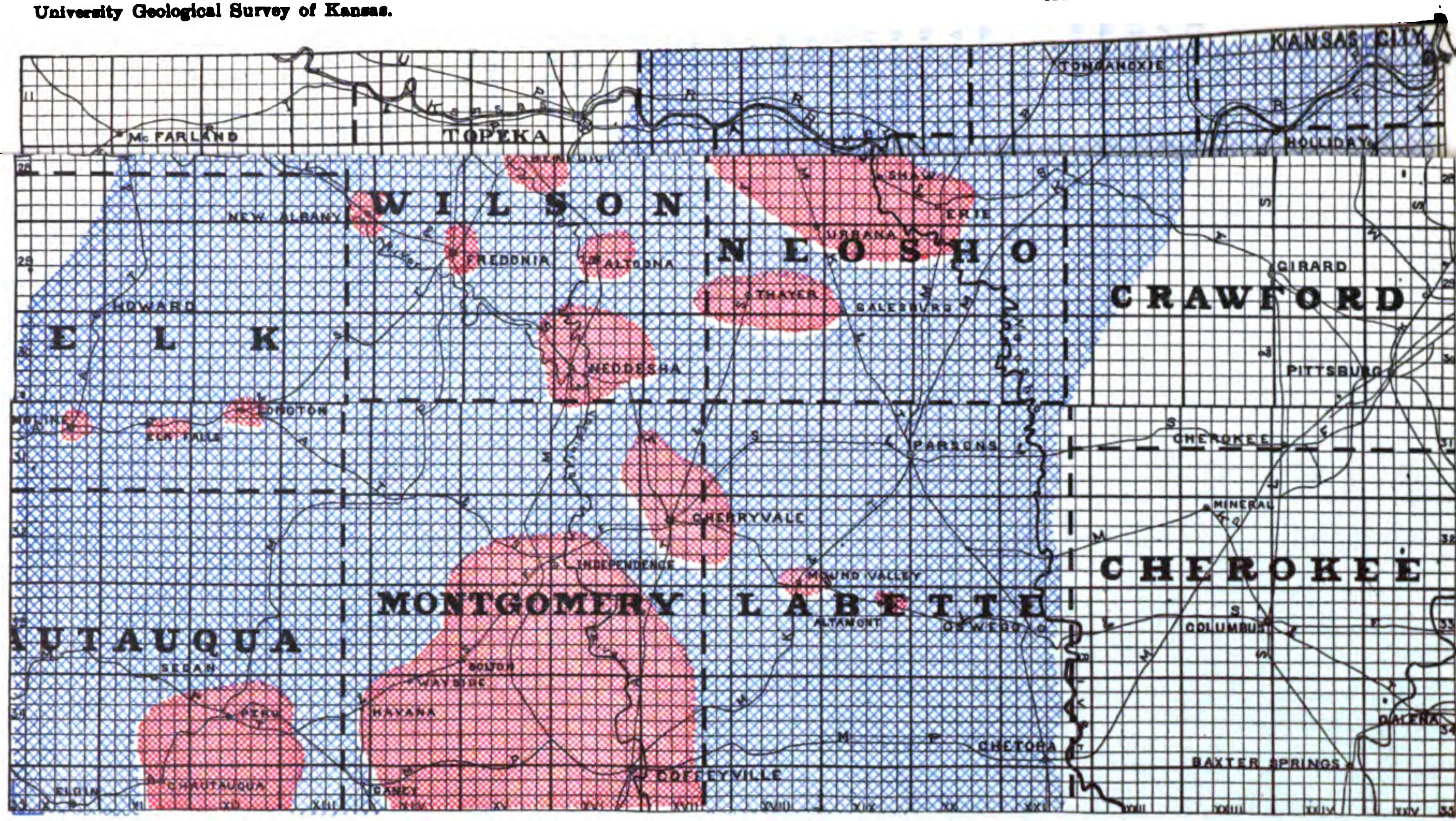
*Totals include estimated value, $9320, of the product from 1889 to 1893, which was 21,100 barrels.

† Refined oil.

CHAUTAUQUA COUNTY.

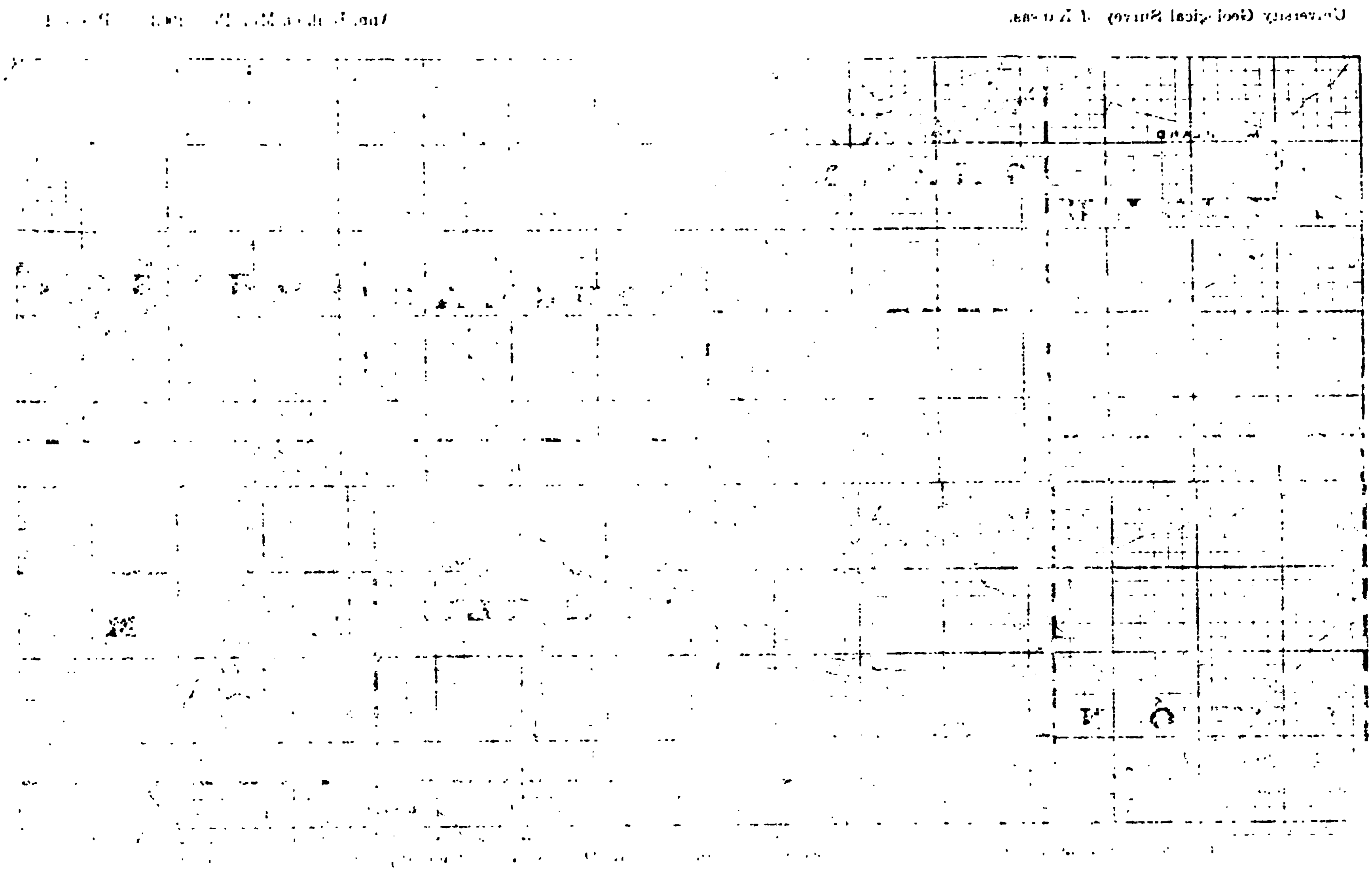
At the beginning of 1903 the only oil wells in Chautauqua county were those situated near Peru, belonging to the Interstate Oil and Gas Company. By March drilling was begun in the Caney valley between Niotaze and Peru, which resulted quite favorably. By July drilling was in active operation within the town of Peru itself and in many places to the south, and particularly along a north-and-south trend from two to four miles farther west than Peru. The first noted well of this region was the Spurlock well, situated in lot 4 in the southwest quarter of section 31, township 34 south, range 12 east. This was followed by a large number of others, almost all of which proved to be good oilers, making the development of this county almost as great as any other one in the state. The so-called Spurlock-Blundell area may be reckoned as one of the best opened in the state. About the same time a fair well producing a very high grade of oil was brought in five or six miles west of Peru, in the northeast quarter of section 22, township 34 south, range 11 east. This area, generally known as the Huffman field, is developing rapidly and was increased in popularity early in 1904 by a well reaching a lower oil sand, 200 feet below the productive sand first obtained. During the last half of the year a very remarkable oil pool was developed north of Peru about two miles. By the close of the year this had become tolerably well circumscribed, showing it to be of small area but of unusual richness.

One of the best pools of the state lies under the town of Peru. Drilling began on town lots within the corporation limits. Each lot owner was free to dispose of his oil rights in any manner desired. The result was that by the close of the year more than fifty wells were drilled within the town limits. Some of them are very close together, being on adjoining lots fifty feet in width. All the wells drilled within the city limits were productive, and many of them pumped regularly, month after month, from twenty to twenty-five barrels per day, few of them falling below fifteen barrels actual production.



MAP SHOWING OIL AND GAS AREAS OF KANSAS.

BLUE shows areas within which Oil and Gas may be expected. RED shows areas of actual production to close of 1903.



ELK COUNTY.

The gas wells at Moline were described in the report for 1902. During the year 1903 prospecting was prosecuted in the vicinity of Elk Falls and Longton, a number of light producing oil and gas wells being obtained. Some drilling has also been done in other parts of the county, but with indifferent success.

WILSON COUNTY.

The development in Wilson county was almost as great as in any other county in the state, and the production was increased very rapidly. Table XII shows that the production for January was 7440.38 barrels, and for December 28,986.48, showing a quadruplication in monthly yield. This increase is confined mostly to the vicinity of Neodesha, although in part to Benedict and Buffalo. Development about Neodesha extended northwest, west, south and southeast from the city. Some wells were obtained which had an initial production of right around 100 barrels per day. The developments at Benedict were confined principally to the Verdigris river valley, both above and below the town. At Buffalo the oil production comes principally from wells to the west and southwest of the town, while gas is found most abundantly to the north. A number of new companies began operations at both of these places. The oil had to be freighted to market by tank cars, as no pipe line was yet built.

TABLE XIV.

SHOWING VALUE OF NATURAL GAS PRODUCED IN KANSAS FROM 1889 TO 1903

Figures for 1889 to 1896, inclusive, are taken from the reports of the U. S. Geological Survey.

YEAR.	Value.	YEAR.	Value.
1889	$15,873	1898	$188,840
1890	12,000	1899	257,500
1891	5,500	1900	602,596
1892	40,795	1901	768,506
1893	50,000	1902	939,375
1894	86,600	1903	1,115,375
1895	112,400	Total	$4,475,616
1896	124,750		
1897	155,500		

The territory from four to eight miles east of Neodesha is developing into an unusually good gas field. Here some of the wells are exceedingly strong, testing from 10,000,000 to 12,000,000 cubic feet per day.

Mr. I. N. Knapp and others have obtained a number of good gas wells in the vicinity of Altoona. Some of the wells lie to the northeast of the town and others to the west. A new gas field was thus opened up where it had generally been understood that no gas of commercial importance existed. Likewise in the vicinity of Fredonia a number of fair gas wells were obtained. Some of them were within a mile or less of the town. One interesting feature is that Fredonia has some shallow gas, being obtained at a little over 300 feet beneath the surface. A similar condition seems to prevail about New Albany, although, in general, prospecting has not been quite so successful here as at Fredonia.

WOODSON COUNTY.

In the future Woodson county must be reckoned as one of the oil counties of the state. Probably the most promising developments are those in the vicinity of Toronto. Here, principally to the southeast of the town, a number of very satisfactory wells were brought in near the close of the year. From the encouragement thus offered a number of companies are beginning operations, making it probable that the year 1904 will witness a production of a nice quantity of oil from this place. For six or eight years oil has been known to exist along the Neosho river in the vicinity of Neosho Falls. Years ago the Palmer Oil Company drilled a small number of wells on the west side of the river—one being at Neosho Falls, the other farther down stream. All of them obtained oil of a high gravity and consequently none of them were shot. At the time it was thought by their superintendent that a sufficient amount of heavy oil could be obtained here to make the development profitable, but nothing was done about it until quite recently, when other companies came in and began drilling. Some of the oil obtained was not so heavy as that produced by the first

wells. At the close of the year matters were still in the prospecting stage, but with very encouraging prospects. Farther up stream, towards Le Roy, a few wells were likewise obtained which gave a fair showing of oil.

LINN COUNTY.

Considerable gas has been found in Linn county. The town of Pleasanton has been supplied with a sufficient amount to light and heat the residence buildings for more than a year. Here the productive wells lie to the south, southeast and southwest of the town. All of them are shallow, from 300 to 500 feet deep. More recently gas has been obtained near Mound City, but not as yet in a very large quantity. It is probable, however, that proper prospecting will meet with better success.

ANDERSON COUNTY.

For two or three years shallow gas has been obtained in the northeast corner of Anderson county, near Greeley. During the year prospecting in that part of the county was fairly successful, producing more gas, and also good traces of oil. This has encouraged outsiders to such an extent that large quantities of the land have been leased. A number of wells have been sunk in the vicinity of Garnett, all of which were failures until just before the close of the year. A well drilled about two miles southeast of the town produced a very encouraging showing of gas, sufficient to stimulate other prospecting.

MIAMI COUNTY.

Early in the year a well was put down about three miles north of Paola which resulted in a light oil well being obtained at a depth of 300 feet. The oil was of high quality, testing 36.5° B. Later other wells drilled to the west and southwest of Paola found shallow oil, sufficient to attract considerable attention and bring a number of companies into the field for obtaining leases and developing. During the winter of 1902–'03 the Paola gas plant was bought by the Osawatomie Gas Company, and a number of new gas wells brought in, which supplied the town very satisfactorily. The same company drilled a number of wells in the vicinity of Springhill, in the extreme northern

part of the county. Here gas was obtained sufficient to supply the demands of the town of Springhill.

In addition to the above described developments, there were a number of others of lesser importance along the borders almost entirely around the area outlined. In some instances very encouraging results were obtained, particularly at different places along the Missouri, Kansas & Texas railroad, in the eastern part of Allen county. The year closed with a fair prospect of development being continued in this way in many places, which not only would enlarge the production, but also very materially enlarge the geographic boundaries of the productive area.

IV.—CLAY PRODUCTS.

THE clay industries of Kansas were very prosperous during 1903. Practically all the old brick plants were kept in operation throughout the year and a number of new ones were built. Of the latter may be mentioned the Fredonia brick plant, at Fredonia, and the Home Brick Company's plant, at Iola, for making dry-pressed brick, and an addition to the plant at Caney for making the same. A number of other plants were enlarged. At Coffeyville a plant was erected for the manufacture of roofing tile and the hollow brick, and the plants at Pittsburg were enlarged so that their capacities were greatly increased.

Common brick aggregates more than half the total value of all the clay products. Building was so extensive, particularly in the prosperous cities in the oil and gas region, that an unusual demand was created for building brick. This was followed closely by the amount of vitrified or paving brick, which in turn was followed closely by sidewalk brick. Paving brick was burned principally in the coal furnaces. In fact, only a few of the gas furnaces are equipped for making vitrified brick. This was brought into prominent notice when the contractor for paving the streets of Iola shipped paving brick from the Lawrence kilns. The anomalous condition of trade was further intensified by certain builders in Lawrence shipping building brick from Iola at the same time.

It is interesting to note that the manufacture of roofing tile has begun in the state, and also that sewer tile of a high quality is made.

The Union Pacific Railway Company discontinued burning "gumbo" for ballast, having ballasted all their line as far west

TABLE XV.

SHOWING AMOUNT, KIND AND VALUE OF KANSAS CLAY PRODUCTS FROM 1892 TO 1903, INCLUSIVE.

Figures for 1893 to 1896, inclusive, are taken from the reports of the U. S. Geological Survey.

YEAR.	Common brick.			Dry-pressed brick. *a*			Re-pressed brick.			Vitrified brick.			Other brick, value.	Drain-tile, value.	Other clay products, value.	Total value.
	No. of thousand.	Av. price per M.	Value.	No. of thousand.	Av. price per M.	Value.	No. of thousand.	Av. price per M.	Value.	No. of thousand.	Av. price per M.	Value.				
1892 *b*.....	25,000	$5 75	$142,750	550	$7 50	$4,125	....	....	....	10,600	$8 00	$34,800	....	$6,000	$5,000	$242,675
1893 *c*.....	20,000	5 75	115,000	1,000	7 50	7,500	....	....	....	8,000	8 00	64,000	....	5,000	4,500	196,000
1894 *d*.....	24,518	5 75	141,042	....	....	....	....	....	....	7,948	7 21	57,310	....	8,048	12,175	218,575
1895.......	20,756	5 87	121,892	3,730	6 91	25,275	....	....	....	7,902	7 87	62,190	....	4,090	33,700	247,647
1896.......	19,694	5 59	110,254	1,541	6 13	9,440	....	....	....	16,934	7 39	125,293	....	4,400	10,700	280,087
1897.......	19,548	5 33	104,257	1,948	5 26	10,241	....	....	....	18,378	7 18	182,222	....	7,600	11,000	265,320
1898.......	23,157	6 34	146,765	5,050	5 55	28,050	1,525	$6 72	$10,250	26,182	7 28	190,735	$6,088	8,592	150	390,630
1899.......	25,750	6 25	160,937	6,225	6 00	37,350	3,275	7 25	25,381	26,478	7 25	181,943	....	9,275	844	415,730
1900.......	56,921	5 36	305,209	*f*	*f*	*f*	7,500	7 50	56,250	44,970	7 12	320,105	21,555	10,250	*e* 116,363	829,732
1901.......	69,706	5 55	386,868	*f*	*f*	*f*	11,665	8 00	93,320	41,319	7 52	310,719	23,175	11,126	*e* 102,600	927,808
1902.......	70,210	4 69	329,284	17,000	8 59	146,030	8,293	5 41	44,865	44,911	7 29	327,619	145,000	5,560	45,000	1,063,881
1903.......	122,030	4 84	590,080	655	9 16	5,830	7,946	6 87	55,105	44,526	7 75	341,014	137,377	2,300	9,450	1,141,156
Totals..	482,290	$5 35	$2,654,338	....	....	....	40,204	$7 09	$285,171	298,178	$7 37	$2,197,950	$333,195	$82,241	$351,482	$6,199,241

a. Previous to 1898 all pressed brick were figured together.
b. Only a partial report is obtainable for 1892.
c. Estimated.
d. For 1894 the common and pressed brick were figured together.
e. Principally for railroad ballast.
f. No report.

as it seemed profitable to haul the material from the "gumbo" beds.

Brick was shipped out of the state to points as far distant as Albuquerque, N. M., on the west, and to the Gulf cities on the south, and to central Nebraska on the north. Prices during the year remained about the same as they have been for a number of years, with a tendency a little stronger. During the summer local competition in the vicinity of Iola cut the prices slightly, but the cut was not general over the state.

V.—GYPSUM.

DURING the year 1903 the Kansas factories making plaster from gypsum did a smaller business than in the preceding year. They marketed a total of a little more than 43,000 tons, with an aggregate value of $159,021. Of this amount almost 37,000 tons was wall plaster and plaster of Paris and a little over 6000 tons was land plaster and rock gypsum, the former being sold quite largely to the packing houses, and the latter to Portland cement factories. At present there are three factories

TABLE XVI.

SHOWING AMOUNT AND VALUE OF GYPSUM PRODUCED IN KANSAS FROM 1889 TO 1903,* INCLUSIVE.

YEAR.	Cement plaster.		Rock gypsum and land plaster.		
	Output in tons (2000 pounds).	Average price per ton.	Output in tons (2000 pounds).	Average price per ton.	Value of output.
1889	17,332	$5 44	....	....	$94,235
1890	20,250	3 58	....	....	72,457
1891	40,217	4 01	....	....	161,322
1892	41,016	4 76	....	....	195,197
1893	43,631	4 16	....	....	181,599
1894	64,889	4 65	....	....	301,884
1895	72,947	3 74	....	....	272,531
1896	49,435	3 00	....	....	148,371
1897	50,045	5 05	....	....	252,811
1898	39,776	3 26	....	....	129,652
1899	61,103	4 30	....	....	262,743
1900	56,112	4 35	....	....	244,611
1901	49,217	4 25	....	....	209,172
1902	51,386	5 00	....	....	256,930
1903	36,929	4 75	6,235 00	$1 68	159,021
Totals for fifteen years	694,285	....	....	....	$2,942,536

* Figures from 1889 to 1896, inclusive, are taken from the reports of the United States Geological Survey.

in the state which use gypsum earth for making wall plaster—the Salina Cement-plaster Company, with a factory at Longford; a plant at Burns, which has been in operation all the year; and one near Dillon, that was in operation a part of the year. The Great Western Plaster Company, at Blue Rapids, manufactures plaster of Paris and sells land plaster and rock gypsum. The United States Gypsum Company, with head office at Chicago, owns a number of plants in the state, as follows: Two at Blue Rapids, one at Hope, and one near Springville.

Table XVI shows the business done in gypsum and its products from 1889 to 1903 inclusive.

VI.—HYDRAULIC AND PORTLAND CEMENT.

Hydraulic Cement.

THE hydraulic cement industry in Kansas remains about the same from year to year. There are two plants at Fort Scott, one located within the city limits, the Fort Scott Hydraulic Cement Company, and another, the Kansas City-Fort Scott Cement Company, located three miles north. These two plants have been operated for a number of years with surprising regularity, each one making 65,000 to 85,000 barrels per year. During 1903 they did about an average business, aggregating a little over 150,000 barrels.

TABLE XVII.

SHOWING AMOUNT AND VALUE OF HYDRAULIC CEMENT PRODUCED IN KANSAS FROM 1888 TO 1903, INCLUSIVE.

The figures from 1888 to 1896, inclusive, are based upon the reports given by the U. S. Geological Survey.

YEAR.	Barrels.	Price per barrel.	Value of output.
1888	40,090	75 cts.	$30,000 00
1889	150,000	70 "	105,000 00
1890	150,000	70 "	105,000 00
1891	140,000	69 "	97,400 00
1892*	110,000	69 "	77,000 00
1893	60,000	35 "	21,000 00
1894	50,000	50 "	25,000 00
1895	140,000	40 "	56,000 00
1896	125,567	40 "	50,226 00
1897	160,000	40 "	64,000 00
1898	160,000	38 "	60,800 00
1899	140,000	45 "	63,000 00
1900	127,339	40 "	50,333 00
1901	131,372	43 "	56,490 00
1902	154,681	50 "	77,340 50
1903	151,795	50 "	75,897 50
Totals	1,990,754	52 cts.	$1,047,527 00

The material used for the manufacture of hydraulic cement at Fort Scott is the lower Fort Scott limestone, a solid bed about five feet thick. Its chemical composition was published in detail in the report for 1897 of this series. It is a moderately impure limestone, containing alumina, silica, iron and magnesia as impurities. With a high grade Portland cement manufactured in the state, as is now done, the market for hydraulic cement is not likely to be very greatly increased.

Portland Cement.

During the year 1903 a new factory for making Portland cement was established at Iola by the Kansas Portland Cement Company. The works are located about three miles east and one mile north of the center of Iola, or a little less than a mile north and east of the town of Gas. They make the "Sunflower" brand, and have an initial capacity of 1500 barrels per day. The raw materials used are practically the same as those used by the Iola Portland Cement Company; that is, the Iola limestone and the overlying Lane shales. The plant is situated at the foot of a small hill from which the shale is obtained, and the limestone, lying under the shale and just under the surface, is quarried near by. In the quarry they use the Ingersoll-Sergeant steam drill, and a Broderick & Bascome rope tramway for transportation. The crushing machinery consists of a No. 8 and a No. 5 Austin gyratory crusher, the larger crusher receiving the limestone directly from the tramway. From here it is conveyed to a revolving screen which takes out about two-thirds of the finer material, leaving about one-third of the coarsest, which is passed on to the smaller sized crusher. The Griffin mills, with wooden frames, are then used for the fine pulverizing. The shale is first reduced by a Williams pulverizer, and later by the Griffin, the same as the limestone. A rotary drier is used for drying the material before it enters the Griffin mills. Eleven rotary kilns, sixty feet in length, are employed for producing the clinker. Vertical cooling towers are employed for cooling the clinker, after which about one and one-half per cent. raw gypsum is added, and the whole pulverized in the Griffin mills with wooden frames, the same as those

used for the raw material. From the pulverizing mills the cement is conveyed to the warehouse by belt conveyors and sacked by portable machines driven by electric motors. The storage bins for the finished product are ten in number, of 8000 barrels each, or an aggregate of 80,000 barrels.

The "wet slurry" process is used in this mill, the same as in the Iola Portland cement plant. Why this style of plant is used for dry material, or material which is dried before it is pulverized, is a question hard to answer, particularly since so large a proportion of the Portland cement mills in America use the "dry slurry" process. In Michigan and at other places where wet marl is used as a raw product, and is not dried before pulverizing, doubtless the wet slurry process is desirable; but with practically dry material to begin with, or any material which is dried before it is pulverized, the addition of the large amount of water necessary to produce the wet slurry greatly reduces the capacity of the rotary kilns and at the same time increases the amount of fuel very materially.

The Iola Portland cement plant was in successful operation throughout the entire year. It is equipped with twenty-one rotary kilns, and can produce, when specially crowded, 3300 barrels per day. It is probable that through the year it averaged about 2000 barrels, and was in operation from 300 to 325 days, making from 600,000 to 700,000 barrels during the year.

The market for Portland cement was quite variable and fluctuating. Early in the year it was high—higher than the average for 1902. By midsummer it had become exceedingly unsteady, and that, too, without any apparent reason, as the demand was kept up and the production was not excessively large. It averaged about $1.25 to $1.35, f. o. b., at the factory.

A number of other factories were designed for Kansas during the year. One was to be located at Independence, a second near Independence, at Table Mound, and at least two others were projected—one for Chanute and one for Neodesha. The actual work of construction had not commenced on either at the close of the year.

VII.—BUILDING STONE.

TABLE XVIII.

SHOWING VALUE OF BUILDING STONE PRODUCED IN KANSAS FROM 1888 TO 1903.

Figures for 1880 to 1896, inclusive, are taken from the reports of the United States Geological Survey.

YEAR.	Sandstone.	Limestone.	Grand totals.
1880	$11,000	$131,570	$142,570
1888*	1,000	144,000	145,570
1889	149,289	478,822	628,111
1890	149,289	478,822	628,111
1891	80,000	300,000	380,000
1892	70,000	310,000	380,000
1893	24,761	175,173	199,934
1894	30,265	241,039	271,304
1895	93,394	316,688	410,082
1896	18,804	158,112	176,916
1897	23,180	173,000	196,180
1898	25,000	180,000	205,000
1899	23,500	550,000	573,500
1900	31,750	455,866	487,616
1901	33,275	495,872	529,157
1902	30,290	505,875	536,165
1903	27,795	610,445	638,240
Totals	$822,592	$5,705,284	$6,528,456

*Reports for 1888 include only (for sandstone) the production from Ritchie; and (for limestone) the production from Winfield, Florence, Augusta, and Oketo.

VIII.—SALT.

THERE was a slight decrease both in production and value of salt in Kansas for the year 1903 compared with 1902, and yet the total value was the greatest of any year in the state's history excepting for 1899 and 1902. The total production was about 1,455,582 barrels, valued at $800,730.74. The principal decrease was in evaporated salt, as the production of rock salt remained about the same. A new plant for making evaporated salt was installed at Ellsworth. Two wells were drilled to the salt-beds mined near by at Kanopolis, and a plant

TABLE XIX.

SHOWING AMOUNT AND VALUE OF KANSAS SALT PRODUCTION FROM 1888 TO 1903, INCLUSIVE.

Statistics for 1888 to 1902, inclusive, from United States Geological Survey reports.

Year.	Barrels.	Average price.	Value.
1888	155,000	$1.219	$189,000 00
1889	450,000	.45	202,500 00
1890	882,666	.45	397,199 00
1891	855,536	.357	304,775 00
1892	1,480,100	.523	773,989 00
1893	1,277,180	.369	471,543 00
1894	1,382,409	.383	529,392 00
1895	1,341,617	.36	483,701 00
1896	1,347,793	.31	519,475 00
1897	1,224,980	.34	417,626 94
1898	1,810,809	.27	489,454 23
1899*	2,172,000	.35	760,200 00
1900	1,679,956	.65	1,091,971 40
1901	1,271,015	.60	762,609 00
1902	1,989,356	.45	895,210 20
1903	1,455,582	.50	800,730 74
Totals	20,775,999	....	$9,089,376 51

* Cooperage in 1899 is reported at about twenty-six cents a barrel, and in other years at proportional rates, which should be added to above totals to give a correct idea of the magnitude of the salt industry.

built, using Portland cement concrete for making the pans, similar to the pans of the Carey Salt Company at Hutchinson. Construction work was not completed until late in the year, so that it scarcely modified the total production of the state. No other new plants were installed during the year, and none were abandoned. The Anthony salt plant changed its name to the Orient Salt Company, and some changes of minor importance were made in ownership at different places.

Table XVIII exhibits the production of salt in the state from 1898 to 1903, inclusive. During this time there has been produced in the state about 20,000,000 barrels, with an aggregate value of a little over $9,000,000.

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